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Engineering News-Record

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Articles on

ITALY'S

GREAT

HIGHWAY

PROGRAM

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Man-Made Earthquakes

Oregon's Coast Highway Bridges

Modern Grab Buckets

Wire-Bound Rock Jetties

Grand Coulee Silhouette—Tower of the Columbia River suspension bridge over which a belt conveyor will transport aggregates to the west mixing plant which starts this month to make concrete for the Grand Coulee Dam.

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Four "Caterpillar" Diesel Seventy-Five Tractors had dirt from this Lorain Shovel (also "Caterpillar" Diesel powered) to build the Charles Mill Dam near Mifflin, Ohio.

Time to Raise the Sights

AS HAS often been remarked by this page, the best thought and effort of the construction industries have been devoted for several years to the problems of survival. Necessarily all those concerned—architects, engineers, contractors, manufacturers, distributors and the rest—have lived from hand to mouth with little thought for any but current needs. Under such conditions management has had to play its cards "close to the chest." It could not see far ahead and what it could see scarcely encouraged the taking of those risks which make for industrial recovery and progress. Distinctly the last few years have been years of conservation, of holding fast.

During recent months, however, marked changes have occurred. Many signs indicate that industrial leadership is passing from the stage of conservation alone into that of rebuilding. In its issue of October 31, for example, this journal reviewed some of the factual data that record progress and reveal trends in construction activities. These show that the noteworthy increase in construction volume during recent weeks cannot be written off as due to government spending alone. A most significant factor is a marked revival of private construction in which industrial building has been setting the pace. Private housing also shows a substantial gain. This increase in private construction has more than neutralized an actual drop in public construction occasioned by the delay in launching the work-relief program. Coupled with this performance is a consistent gain in the volume of private capital issues that began last year, has continued at an increased pace during 1935 and constitutes a certain augury of continued progress.

MANY alert architects and engineers have found in such work a toe-hold for their climb back to more productive employment. Many producers of materials and equipment who have kept everlastingly and intelligently at it are finding a reflection of this improvement in their sales figures for the current year. To be sure, all have not participated equally in this improvement; but all have not been equally adapted to the work thus far available and certainly all have not shown equally aggressive and consistent effort to make the most of the opportunities that have been open to them.

So much for the past. Today, however, our concern is with the outlook for the future and with our plans to make the most of the present trend for the better. It is time for us all to raise our sights, to think less exclusively in terms of immediate problems and more consistently in those of sustained progress. Decidedly the test of management at this time must be its ability to reconcile long term values and immediate necessities, to think and plan in terms of years rather than of months. Substantial business usually is built on a foundation of vision and planning rather than of opportunism and expediency. It is true that each day always brings its own problems which must be met and dealt with skillfully, but however resourcefully management may cope with the daily emergencies, substantial success will depend chiefly on having a definite objective, a long term program and on consistent, resolute performance.

THESE requirements of business building will be dominant also in the reconstruction period upon which we are entering. In every department of construction new enterprises and new products, representing new blood and answering new needs, are rising to contest the leadership of older houses, often hampered by tradition and custom; many concerns of long standing have cleaned house, and with modernized products and managements are coming back refreshed and unencumbered. In this new competition between the old and the new, the "would-bes" and the "has-beens," they are most likely to catch the present tide of recovery and to travel farthest during the next five years who now are formulating policies, laying plans and organizing their efforts with a view to consistent and sustained progress as well as to meet the more pressing necessities of today.

All this is reflected in the programs now being laid down by forward-looking executives in every department of the construction industry. No longer are they content *to let their jobs run them;* from now on *they are going to run their jobs.* And it is just that spirit that will write the successes of the next few years.

Willard Chevalier

ENGINEERING NEWS-RECORD

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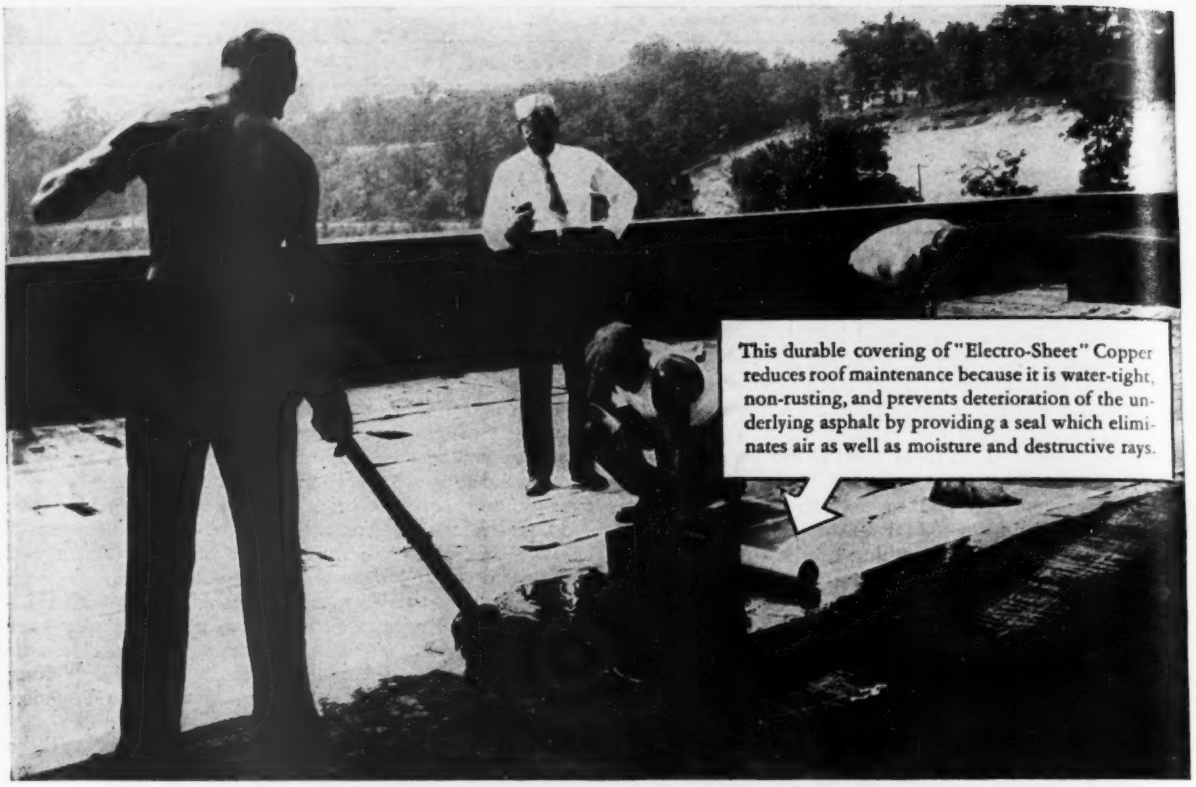
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In the News:

ARMISTICE DAY witnessed the virtual completion of two notable traffic arteries—a new bridge connecting Davenport, Iowa, and Moline, Ill., and a new parkway connecting Brooklyn with the Long Island State Parkway System in New York. A thousand miles apart, these two projects serve a common purpose in eliminating an important barrier to highway travel. Whether the Mississippi River (in the first instance) or the old and winding highways of Brooklyn or Queens, which are superseded by the Interborough Parkway, is the greater barrier is proper subject for debate.

FOREIGN STEEL SHEETPILING has been ordered recently for two PWA projects—an ocean terminal in Morehead City, N. C., and the Triborough Bridge (for cofferdam enclosures) in New York City. Apparently the price paid was at least 15 per cent less than American firms bid, which is the PWA requirement for use of foreign materials.

MUNICIPAL POWER PLANTS financed by PWA have received $46,268,900 from old funds and $6,106,835 from new funds. The latter represents 63 generating plants. In addition, $1,966,000 has been allotted for 23 distribution systems.

THE PROPOSED WORLD'S FAIR in New York will occupy a site bordered on the west by the new Grand Central Parkway Extension—the Triborough Bridge Route. Last week, bids were received totaling $1,000,000 and covering all remaining grading, drainage and bridge work on this Fair site section.

KNICKERBOCKER VILLAGE, the RFC-financed slum-clearance project in New York, cost $2.43 per sq.ft., $1,165 per room. The two twelve-story apartments contain 1,591 dwelling units. Materials accounted for 42.4 per cent of the $6,216,899 cost, exclusive of land. Labor at the site received between 35 and 40 per cent of this total, the remainder going to overhead and other items.

STRUCTURAL-STEEL AWARDS since the first of the year have totaled slightly over 1,000,000 tons, or about 8 per cent more than last year. Unfortunately, the 1,000,000 tons is only about 5 per cent of the steel production. Prices are advancing on both pig iron and semi-finished steel.

THE PROPOSED TUNNEL under the East River at New York gained the support of the RFC last week, with qualifications. If the PWA will furnish a grant of $11,250,000, the RFC will loan the remainder of the cost—namely, $47,130,000. An application for a PWA loan of $43,224,000 and a grant of $15,141,000 has already been made.

OCTOBER was the "biggest home-building month in four years," reports the Federal Home Loan Bank Board. The awards were $55,100,000.

FIFTY HOUSES of earthquake-proof construction are planned for Helena, Mont., by a company formed by civic leaders of the town. The FHA has granted insurance for the necessary loans.

In This Issue:

THE ROAD TO ROME, which Cæsar paved with cobblestones and which succeeding generations did little to improve, has finally disappeared. The past decade has witnessed the creation in Italy of a road system that in quality challenges comparison with the modern highways of the world and in certain design practices is open to critism, but from any viewpoint is an accomplishment that warrants study. Two experts, well qualified to judge, analyze this accomplishment in this issue.

TESTS OF VIBRATED CONCRETE, in standard cylinder specimens, demonstrate possible savings in cement and reduction in shrinkage by the use of this modern method of placement.

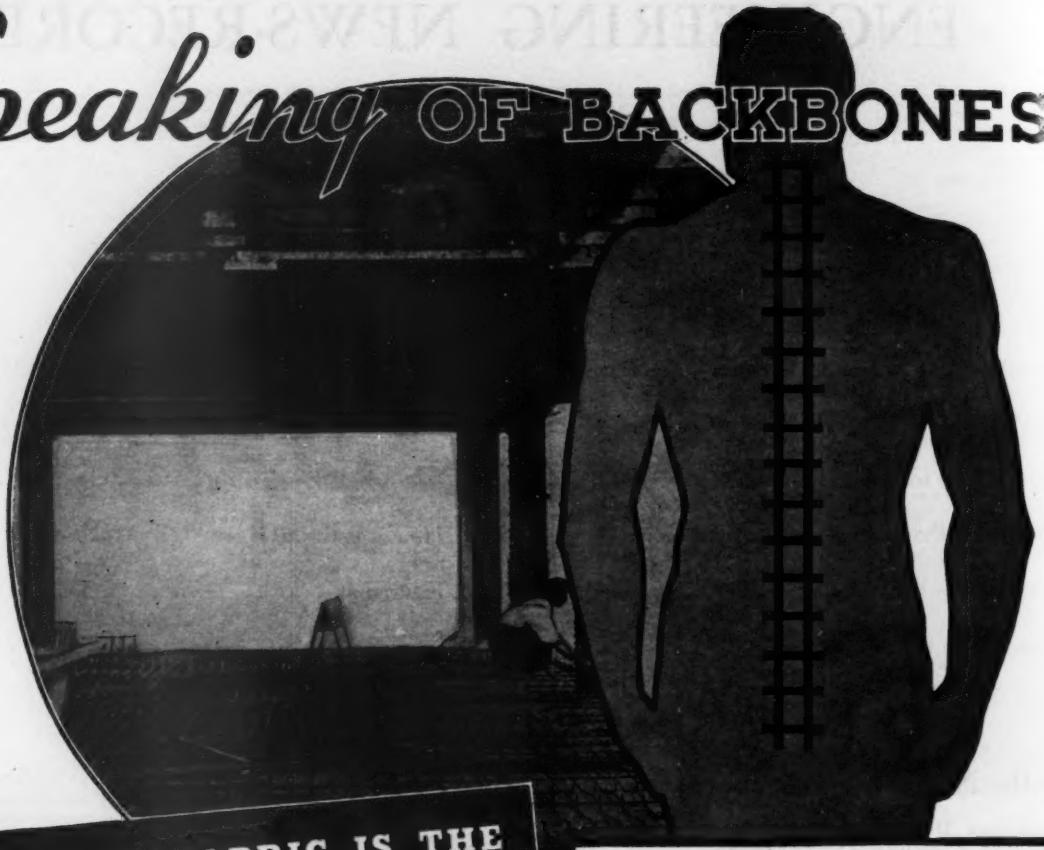
OREGON is building five major bridges along its Coast Highway, to replace as many time-consuming ferries. Concrete bowstrings, continuous concrete girders, concrete arches and a 793-ft.-span steel cantilever are included. The several interesting design and construction elements are reviewed by C. B. McCullough, until recently assistant state highway engineer of Oregon and now in charge of bridge building on the Pan American Highway for the U. S. Bureau of Public Roads.

VIBRATING OF SKYSCRAPERS, dams and bridges to simulate earthquake effects and thus determine the dynamic behavior of such structures is the important work recently undertaken by the U. S. Coast and Geodetic Survey, using a machine developed by Prof. L. S. Jacobsen and John A. Blume, of Stanford University. The results obtained so far are outlined by Franklin P. Ulrich, who is in charge of the work when he is not trouble-shooting on current quakes, as in Helena, Mont., where he obtained important records of the serious Oct. 31 movement.

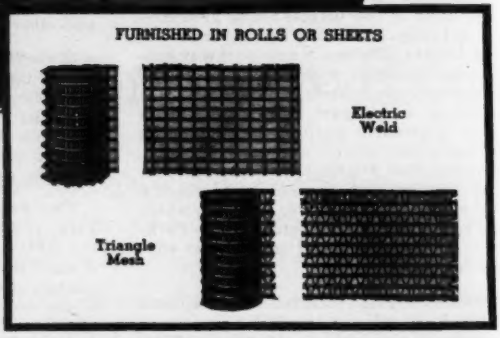
BASKET DIKES, revetments of stone bundled in wire mesh, are proving efficient structures in the Virgin River in Utah's Zion National Park, where torrential freshets have caused devastating erosion. The dikes not only hold the channel in a well-defined course but are building up the eroded valley with new vegetation-growing soil.

CLAMSHELL-BUCKET DESIGN along modern lines and much practical advice on choosing the proper type bucket for given working conditions are presented in an article by an engineer specialist in this important field.

Speaking OF BACKBONES



This WIRE FABRIC IS THE Backbone of FLOOR SLAB CONSTRUCTION



WHATEVER the method employed in constructing a concrete floor, there is one reinforcing material that meets all requirements. It is American Steel & Wire Company Wire Fabric. This giant backbone of permanence reinforces the slab in every direction, and that means a long life floor. The closely spaced wire members bind the slab together thereby safeguarding every penny invested in construction costs. Equally important, this "backbone" is easily and quickly placed—lays flat—is convenient to handle. The time and labor saving, alone, is a big item. On your next job, be sure to command all of these advantages. By specifying American Steel & Wire Company Wire Fabric, you make certain of the reinforcing result—and you also get perfect service and cooperation.

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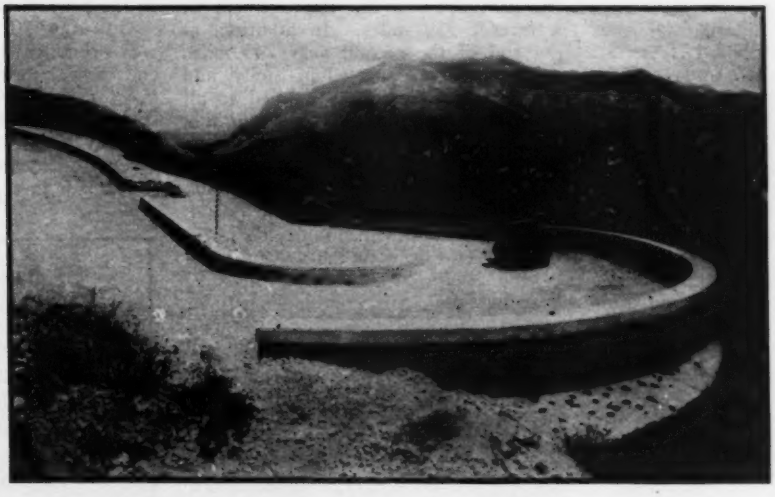


"LE SVOLTE" or bend in the road from Aguila to Papoli, giving Rome a paved route east to the Adriatic.

Development of the Roads of Italy

From the most miserable road system of Europe, Italy is creating a state-road and superhighway system that in quality challenges comparison with the highways of the world

By B. P. Root

Highway Specialist, Bureau of Foreign and Domestic Commerce, U. S. Dept. of Commerce, Washington, D. C.

IN THE SHORT SPACE of ten years Italy has reconstructed a system of highways equal to that of any country and superior to that of most countries. This article is limited to a factual account of the work accomplished based on the reports to the Bureau of Foreign and Domestic Commerce from the commercial attachés and trade commissioners of the Department of Commerce and also those rendered by consular officials of the Department of State stationed in Italy. Statistical and financial data are from official annual reports of the Autonomous Road Board, Italian trade publications and other reliable sources.

Italian road improvement divides fairly closely into reconstruction of the state road system; the construction of high-speed express highways—the famous autostrade; heavy truck roads, and colonial roads in north Africa. This classification has been followed in this article.

In 1922 and 1923 it began to be urgent that something radical be done to Italy's roads. The registration of motor vehicles in 1923 had reached 75,000, exclusive of motorcycles. The road mileage at that time was nearly the same as in 1934, which was reported at 105,458 miles, but most of this mileage was ordinary dirt road, with some gravel and waterbound macadam, dusty in summer and impassable in winter. Then in 1923 there began a rapid increase in the number of automobile registrations, with a more widely diffused ownership, and it became urgent that the reconstruction and proper maintenance of the main highways be undertaken on a large scale to transform them from animal-ways to modern motor roads. In 1927 the registration of vehicles had increased to 138,177, in 1929 the figure was 188,952. The data for 1934 show 347,264 motor vehicles registered (these figures are exclusive of motorcycles).

- **The improvement of Italian highways in the last ten years takes high rank among the public works of nations. In this brief period Italy has regenerated its national highway administration; brought a large percentage of its antiquated public-road mileage to very high standards, and built some of the highest-type express highways to be found in any country.**
- **The articles that follow outline this progress and the administration organization and policies that have directed it and furnish a current appraisal of the technical and traffic service accomplished. The articles are based on personal study this year of the roads themselves and on the extensive reports to the Department of Commerce of American government representatives in Italy.**
- **With this authority back of them the articles provide the most reliable and comprehensive account that American engineers have had of the modern roads of Italy.**

Administration and early progress

The construction and maintenance of the roads prior to 1928 was a function of the Ministry of Public Works, but this was changed. In connection with the stupendous program of land reclamation and the improvement of farm lands on a vast scale, also involving numerous public works improvements (railway construction, hydro-electric work, harbor works, aqueducts and

sanitary engineering) provided for in the Law of Dec. 24, 1928, to cover a period of fourteen years, the work of road development was considered such an important part of the proposed grand rehabilitation plan for Italy that in July, 1928, the government established a special state road board (Azienda Autonoma Statale della Strada), which was charged with taking over for reconstruction, repair and maintenance certain of the state roads, which included Italy's 137 national routes, totaling 12,813 miles, and having advisory supervision of all other provincial and local roads.

To this new body, directly responsible for the state highway system, was assigned the revenue from the circulation tax and other road-upkeep taxes on motor vehicles, amounting to $9,047,200 in the fiscal year 1929-1930, besides an annual grant of $9,468,000 each year for a period of 20 years, and the receipts from charges for roadside advertising, fines for traffic violations and other minor sources of income, averaging $1,052,000 each year.

In the first year of the existence of the Autonomous Road Board, 1928-1929, 780 miles of the state roads were thoroughly repaired, widened and in many cases rebuilt. This was increased in the second year to 1,478 miles; while the program for the third year, 1930-31, provided for the improvement of a further 959 miles. In addition, at the end of the second year 744 miles had been surface-treated in Sicily, and this treatment had been applied to all national roads ready for such improvement.

At the end of the fourth year after the organization of the Azienda it was supposed to have put in order 3,728 miles of the total placed under its jurisdiction. However, at the end of June, 1932, it reported that 4,800 miles of surfacing had been accomplished, of which 4,438 had been surfaced with asphalt or tar mixtures, and 342 had been improved by permanent or semi-permanent methods. Such rapid progress had been made that by the middle of 1932 the Azienda had assumed obligations of roughly $151,740,000 and had already made payments of about $66,810,000.

During this first four years of the Azienda, in addition to the accomplishments noted, 205 miles of route had been relocated, 600 new bridges built, 65 grade-crossings eliminated and another 27 placed under control. Also 400,000 young trees had been planted in the plan of roadside beautification.

On May 30, 1929, a royal decree was promulgated which gave the Azienda power to apply an annual integral tax for the use of the roads to those corporations, companies or individuals who by the transit of vehicles would give rise to exceptional wear on the state roads in certain zones, originating from the business carried on by them. This integral tax is applied on the basis of the intensity of the traffic and its duration, the type of the vehicles, the distances regularly covered, the nature and weight of the goods and the extra expense borne by the state administration for the upkeep of those roads covered by the factory or corporation.

EXPRESS HIGHWAYS (autostrade) of Italy as completed and originally planned to connect the extreme boundaries with high-speed roads.

MAIN ROADS OF ITALY. The map shows the superhighways (autostrade) and the progress of improvement of the state road system.

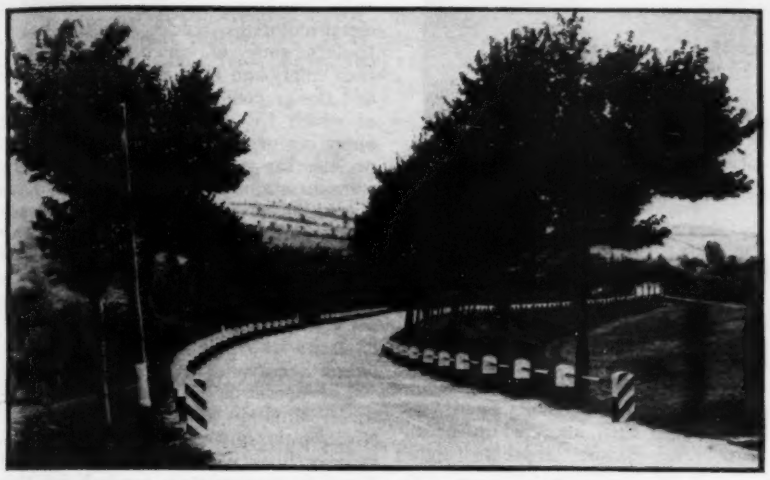
Six years' progress

On June 30, 1934, the Azienda reported that its operations for the six-year period had completed improvement of 6,079 miles of the state system. Of the above distance, 5,763 miles used the five lower types of macadam improvement and surface treatment, while the remaining 316 miles were of the higher types (bituminous concrete 116 miles, asphalt 32 miles, cement concrete 53 miles, stone block 112 miles, and other high types of experimental surfaces of various kinds 5.8 miles). There were also in course of construction or improvement 482 miles of the lower types of surfaces and 5 miles of the higher types, there being the grand total of 6,566 miles improved and in course of improvement, or one-half of the total state highway system.

In addition to the general surface improvement of the national roads, during the six-year period of its adminis-

tration the Azienda constructed 1,714 bridges of spans up to 33 ft. and 177 of spans 33 to 164 ft.; also 44 viaducts having spans of more than 164 ft. were completed and nine more where under construction.

At the beginning of work by the Azienda there were on the state roads 856 grade-crossings; of this number 107 had been eliminated by June 30, 1934, and the abolition of ten more was under way. Other accomplishments of the board during this six-year period were:



ROAD FROM RIMINI on the coast of the Adriatic to San Marino, the little independent republic of 38 sq.mi. that claims to be the oldest state in Europe.

the erection of 11,180 road signs and the planting of 941,486 trees in the roadside beautification plan of the Azienda, for a distance of 3,890 miles, or nearly one-third of the total length of the state system. Seven large snow plows and 25 smaller snow-removal machines had been acquired for those roads in the higher mountains in the northern part of the country. During the period of the present administration, 1,226 residences with 3,230 rooms have been erected. This means that more than one-half of the homes required for housing the road guards have been provided.

A summary of budgetary obligations under the Azienda during the three two-year periods of the state financing are noted as follows: For maintenance, 1,237,229,176 lire; for general systemization, 1,728,759,096; and for extraordinary reparation, 289,092,411 lire, or a total for the six years of 3,255,080,683 lire (approximately $262,033,900 U. S. at present exchange rates). This is a tremendous expenditure commitment for a country the size of Italy. The remarkable progress that has been made in road reconstruction and the attempt toward motorizing a great part of the country's transport is one of the outstanding public-works accomplishments in Europe.

In addition to the extensive system of improvement undertaken by the semi-autonomous organization, the Azienda, for a state system of highways, there have been constructed in various parts of Italy a number of superhighways known as "autostrade," or high-speed motorways. These roads are not characteristic of the general roadway system of the state, but nearly all of them are toll roads built by private corporations under government authorization and with government assistance. These fine examples of the roadbuilder's art in Italy have no counterpart in any part of the world, except the new system of high-speed double-roadway highways now under construction in Germany. There are no grade-crossings, and all intersections with other roads are either separated by overhead viaducts or underpasses.

On these modern cousins of the famous roads of the Roman Empire, remarkable triumphs of highway engineering, even more wonderful than those built before the Christian era, big Italian, French, German, English and American automobiles shoot like rubber-tired cannonballs. The foreign motor tourists who came into Italy in the last few years in increasing numbers prefer the autostrade because they permit of speed limited only by the mechanical possibilities of their cars.

The first of these famous speedways, connecting Milan with Como, Varese and Sesto Calende (the first and second located on lakes of the same names, and Sesto Calende near Lake Maggiore), with a total length of 52.6 miles, was begun by a private construction and operating company, the Societa Anonima Puricelli, in 1923 and was completed in 1925.

This first project was financed almost entirely by private capital, although some contributions were made by the municipalities traversed by the road. Central government assistance was also given, largely along legal lines, especially in the acquisition of the land required for right-of-way. The company was granted a 50-year franchise, after which time the road was to revert to the state. In the first year of operation the revenue was barely sufficient to meet carrying charges; in the second year a 2 per cent dividend was declared. Modest dividends were made for a few years, but after the depression years had so adversely affected the revenues the state took over the road, and it is now operated by the Azienda on a reduced toll-charge basis.

COVERED ROAD (Mezza Galleria) on the road above Anversa (Valle del Sagettario) in the province of Abruzzi.

The cost of construction averaged about $76,600 a mile, but in some instances, due to special terrain conditions and local circumstances, the figure reached as much as $229,000 a mile.

The main straight road runs from Milan direct to Lake Maggiore (Sesto Calende); branches go to Como and Varese. The first 20.5 miles of the road is 33 ft. wide, with two side tracks of 6½ ft.; for the remainder of the total distance, 33 miles, the road is 26 ft. wide and has two 5-ft. side tracks. All curves on this autostrada have a radius of over 1,640 ft., and there are no grades over 3 per cent. On all the autostrade the most modern asphalt and concrete surfaces have been used.

Milan-Turin Autostrada — The first part of a main autostrada projected from Turin to Venice, which would cross Italy from the west to east, is completed from Milan to Turin as a trunk line. It is about 78 miles long and shortens the distance by railway 15.5 miles.

The whole route has a total width of 33 ft., with side tracks. All curves have a radius of over 3,280 ft., and no grades exceed 3 per cent. There are no

OVERHEAD CROSSING of an Italian road, characteristic of many recent grade separations.

railway crossings, but the road has 22 large bridges, two of which are respectively 1,000 and 1,138 ft. in length. These are over the Sesia and Ticino rivers.

Milan-Bergamo-Brescia — East of Milan on the proposed trunk line to Venice the two sections between Milan to Bergamo and from Bergamo to Brescia are completed and in operation. From Milan to Bergamo the distance is about 30 miles and from Bergamo to Brescia about 28 miles. The minimum radius of curves is 2,624 ft. and as on the western section the width is 33 ft. with side tracks, and the maximum gradients are not more than 3 per cent.

Venice-Padua—On the other end of the main trunk line the section from Venice to Padua of 15 miles was completed in 1934. It is expected that it will be continued westward through Verona to Brescia, which would complete the main trunk line. The width of this section is the same as mentioned previously, 33 ft., with no gradients over 2½ per cent.

Naples to Pompeii—The first section of an autostrada, which it is proposed to extend from Naples to Palermo in the future, is 13 miles in length, with no gradients over 4.55 per cent. This road is essentially a tourist route at the foot of Vesuvius.

Florence-Viareggio—A tourist route intended eventually to connect Florence with the seashore via Pistoia, Lucca and Montecatini—shortest to the sea—is 50.5 miles long. It has the almost-standard autostrada width of 33 ft., with gradients up to 3 per cent and on one short length 5.5 per cent, with curves not under 984-ft. radius.

Rome-Ostia—This is one of the more important of the autostrade. This main road between Rome and its seaport and popular seaside resort is 14.5 miles long, 33 ft. wide, and provides for high-speed motor-vehicle traffic without the country mule carts and bicycles which once made motoring from Rome to Ostia somewhat difficult. This route was constructed by the government and is operated toll-free. It is lighted by 2,900 lamps, which gives it the appearance at night of a band of white stretching across the Campagna. Such improvements as this, executed at great expense and labor, impress upon foreigners the progressiveness of the present government.

The Truck Highway—For several years the motor transport of freight from Genoa to inland industrial centers and products from these centers to Genoa, the nearest seaport, had grown so rapidly that the highway routes became entirely inadequate, and in 1932 it was decided to construct a highway for truck traffic only. It was proposed for the first section to cross the Apennines and to connect with already-existing roads to Milan and Turin, which would be improved and become the Italian end of a great north-south thoroughfare across Europe. The north end of this route was supposed to branch in Germany and have lines to the ports of Lübeck, Hamburg and Bremen. In 1932 legislation authorizing the construction of an entirely new road from Genoa to Serravalle provided that the expense of building this part of the road should be borne by the state with possible contributions from the city of Genoa and other localities benefited by the improvement. The first appropriation was for $5,000,000 for the first stages of construction, which started Oct. 28, 1932, just six months after the idea was conceived. It is to provide rapid truck transportation between industrial plants in Milan, Turin and the vessels at the seaport of Genoa, where many quays of the port could not be reached by the existing railroads.

The construction encountered serious difficulties in the section from Genoa to Serravalle, a distance of 29 miles over the Apennine pass of the Giovi. The gradients do not exceed 4 per cent, and the radius of the curves is not under 328 ft. The highway is 33 ft. wide throughout, even in the tunnels. The gradients in all the tunnels do not exceed 3 per cent. One of the tunnels is 2,996 ft., another 2,952 ft. In all there are eleven tunnels with a total length of 1.73 miles and 28 bridges and viaducts representing a length of 1.58 miles. While construction is still under way it is estimated that the cost will be more than $12,500,000.

When the road is completed to Serravalle the large number of enormous diesel-motored trucks with heavy trailers, some of which weigh 3 tons each empty and 12 tons loaded, the truck and trailer combined weighing 24 tons, of which 15 tons are load, will begin operating over this new route, built especially for such heavy units of motor transportation. These large units have played havoc with the ordinary roads over which they have been transporting commodities between Genoa, Milan and other interior industrial cities. It is thought that the weight of these large carriers will have a bearing on the necessity of rebuilding the sections between Serravalle to Milan and Turin.

The operation of these large truck-trailer units has already had an adverse effect on the earnings of the state-owned railway lines which they parallel, and it will be interesting to see how far this motor competition will be allowed to develop and what will be its ultimate effect on the railways, as it is said that the development of this particular truck highway is one of the pet projects of the government.

Future of the Autostrade—There are now eight autostrade on which construction has been completed, a total length of 282 miles. The longest of these super highways is the section of 78 miles between Milan and Turin, and the shortest the 14.5-mile road between Rome and Ostia.

It has been estimated that the total cost of all these autostrade is $50,000,000 at present exchange, and there is a yearly subvention by the government of about $944,100. With the exception of the construction now in progress on the truck highway there has been no new work on autostrade in Italy since 1934.

With the national roads being rapidly improved and resurfaced and furnishing traffic facilities almost equal to the autostrade, the toll receipts have dwindled until it is doubtful if the ambitious project of a few years ago to connect all main centers of population with superhighways will be entirely realized. Local traffic in the areas of the autostrade largely uses the toll-free state roads, and the number of foreign tourists entering Italy is entirely too small for the main support of the autostrade for some time to come. To the motoring Italian public the autostrade are no longer a novelty, but rather a luxury

easily dispensed with during hard times. It is therefore felt that the operation of toll roads in Italy will not be an extremely lucrative venture.

Important colonial development

For several years the colonial administration at Rome has been active in developing a system of roads in the African colonies. In Libya, important highways have been constructed to the interiors and along the coasts of both Tripolitania and Cyrenaica. From the Tunisian frontier to that of Egypt a road comparable in construction to the autostrade has been constructed. It is now possible to motor from Egypt to Morocco and, by ferrying, on through Spain to European points. The most ambitious and active program recently developed is the construction of roads in the East African colonies, obviously for strategic purposes. The program is reported to comprise more than 497 miles of roads. Eighteen different highways were to be completed in Eritrea alone before the end of October, 1935. They are to include a wide motor road for the main traffic from the coast to the high plateau region. In addition, four parallel roads to establish further connection with the plateau from the lowlands, two cross-connection roads, and one auxiliary road from Massaua to Amara are also contemplated. A large number of bridges and special works will be required.

The funicular railway from Ghinda to Amara will be of considerable assistance in carrying out this program of road work, and will make it possible to transport daily some 600 tons of materials from the low-lying coast land to the high plateau. On the existing roads another 500 tons can be transported each day, but these transport facilities are to be increased to a total of 3,000 tons daily. A short time ago there were 22,000 men employed on these road works in Eritrea, but the force was to be increased to 30,000.

A Touring Engineer's Impressions of the Roads of Italy

Good surface and structures, technical study, attention to appearance, excellent construction and maintenance organization stand in contrast to dangerous alignment and many hazards of design practice

By John S. Crandell
Professor of Highway Engineering, University of Illinois, Urbana, Ill.

HE WHO VISITS ITALY today will be amazed at the network of excellent highways over which he may travel; if he has experienced the difficulties of motoring over Italian roads in pre-fascist days, his amazement will be all the greater. In 1922 the roads were in the same condition in which American roads were in 1905; the streets of some of the larger cities were paved with stone block or occasionally Sicilian asphalt, the roads leading to the suburbs were macadamized, some of the main routes had either indifferent macadam or miserable gravel surfaces. But when Il Duce said, "Make war on the dust" in 1922 a new era began. Today the motorist may travel over thousands of miles of dustless highways, wonderfully maintained, well marked with suitable signs and worthy of high praise. The author has this year traveled 2,500 miles on these Italian roads, and the observations that follow are those made during the trip in March and April, 1935.

Improved administration responsible

Prior to 1922 the national highway system was loosely administered. But with the advent of the fascist government, law No. 1601 was passed on Dec. 3 of that year and the government obtained full power to achieve reforms. Among these the reconstruction of the bureau of public works was preëminent. It is not necessary here to trace the several changes in organization that were made, but it is well to call attention to the fact that the bureau is under the control of the minister of public works, and that there is a central technical service division, formed in 1931, which reports directly to him. The work of this division includes preparation of the general program of public works, study of technical regulations and projects of great importance, technical control of the bureau of civil engineering, registration of the survey of lands of the bureau of public works, preparation of publications, and technical study, including research in matters of technical and scientific character.

An experimental laboratory was established under the direction of the technical service. Studies of reinforced concrete and of Italian asphalts have been made.

Although some work was done beginning with 1922, it was not until 1928 that real progress began. In that year the Azienda Autonoma Statale Della Strada (A.A.S.S.), or Autonomous Administration of State Streets, was created to take over the technical management of the network of the most important roads, which were given the name of National Highways. The law creating A.A.S.S. also provided an income. A sort of five-year plan for paving was adopted late in 1928 under which about 3,700 miles of highway were to be systematically rebuilt.

Actually, the full planned income was

TYPICAL improved highway of Italy near Siena. Note concrete curb and stone gutters, inlets, catchbasins and roadside markers. Highway direction sign is alongside the tree. Surfacing is asphalt macadam.

AUTOSTRADA from Rome to Ostia; note the lighting system and tree planting; the prevalence of advertising signs is typical.

not received because the government reduced its grant, and automobile fees and taxes did not increase with the improvement of the roads as had been expected. In spite of these reductions, however, the program originally outlined in 1928 was more than completed in 1934, for, instead of 3,700 miles, nearly 6,200 miles had been rebuilt, 430 important changes in alignment made, curves flattened, visibility improved, nearly 700 new bridges and viaducts built, 117 grade-crossings eliminated, 376 homes for maintenance crews built with 119 more under way, and the roadsides planted with trees.

When A.A.S.S. began to function in 1928, it found that of the 12,826 miles of national roads only 277 miles were anything better than plain untreated macadam in very poor condition. By 1934 this state of affairs had been changed, for 6,080 miles had been made dustless either by surface-treating the existing macadam after suitable repairs had been made or by replacing the old surface with some improved form of pavement. At the moment about 6,200 miles still are plain macadam, but they are excellently maintained and, except for being dusty, they are serviceable and easy to drive over. Many hundreds of miles of the 6,080 above-mentioned could not be "improved"; complete relocation and rebuilding were necessary, for most of the old roads were but 12 ft. wide, with crooked alignment, on dangerous fills and wholly unsuited to mere improvement. Less than 2 per cent were paved.

The fields of A.A.S.S. activities are ordinary maintenance, extraordinary repairs, and a general putting in order of the system of national roads. Holding that what isn't maintained soon goes bad, thus preventing the end being achieved for which the structure was built, A.A.S.S. enforces systematic and constant maintenance throughout the system.

Under the heading "extraordinary repairs" are such matters as replacing roads and bridges destroyed by storm, earthquake or other unusual means. Many important works have been constructed, new bridges built in place of unsafe old ones, sections of old highway that were impossible for motor traffic rebuilt, and antiquated roads generally modernized.

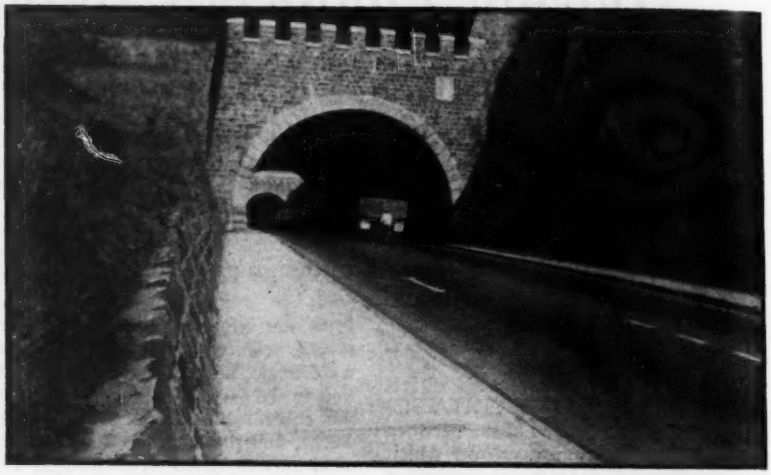
The putting in order of roads constitutes the fundamental aim for which A.A.S.S. was created, and this is the most important and the costliest of its duties. It was desirable to put the entire system in first-class order in the least possible time, in spite of the fact that Italy started rather late. Macadam will continue for many years to be the bulwark of the road system, but it is rapidly being made dustless, smooth and safe.

A.A.S.S. discarded the old methods of maintenance, such as we formerly practiced in our country, and introduced national maintenance, taking all such work out of local hands and politics. The results have been surprisingly excellent. The work is given over to maintenance men ("cantoniere"), who number 4,700, and of whom 500 are chiefs. Complete information as to the condition of the roads is always on hand, and monthly statements are made of the entire system. Cards are then issued to the maintenance men, indicating what should be done to improve their sections. From the information thus furnished, the Royal Automobile Club of Italy makes and issues bulletins similar to our state detour maps.

Experimentation emphasized

More and more the laboratory reports are relied on to indicate what should be done. Field and laboratory experiments have been combined. One very interesting set of experiments in the field was

TYPICAL ROAD TUNNEL, one of many on this road near Trieste. Note the stone walls and the curb marking.



begun on the Milan-Pavia road in 1929. Italy has an enormous number of animal-drawn vehicles that carry very heavy loads. On this road was laid a series of 160 trial sections of portland cement concrete pavement, varying materials and proportions in all reasonable combinations. The aim was to measure the wear and tear on the pavement from steel-tired vehicles. It was feared that this would be such as to restrict the concrete pavement to motor roads. It may be recalled that Spain found this to be true, and finally used the concrete as a foundation for granite blocks, on rural roads as well as in the cities. In order to expedite matters, an artificially heavy traffic was introduced. A report is in preparation; but "Strada Sperimentale di Binasco, Lungo la Strada Statale n. 35 dei Giovi," A.A.S.S., Milano 1934-XII, gives details of construction.

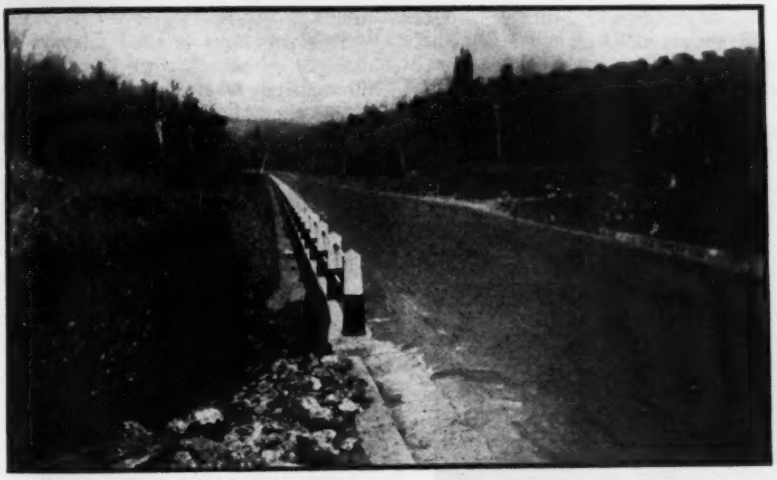
On the same roads another series was begun in 1931, using bituminous materials. Each section is 164 ft. long, and there are 50 or more sections, new ones being added from time to time as novel and interesting methods are thought of. All types of hot, cold and emulsified asphalts and tars were tried, with the hope of forming a thick carpet coat combined with suitable covering material,

rather than the customary light surface treatment.

"It will be understood," says the report, "that an immediate answer is not forthcoming, even though the road is under artificially heavy traffic, for each trial section is strongly influenced by an element that cannot be artificially altered: the climate, with its many thermometric and hydrometric changes." It would be well for our American highway-engineering brethren to make note of this same statement. These experiments have already been of value in indicating the proper bitumen to use in hot dry climates. The technique of mixing various asphalts, or asphalts and tars, as well as using asphaltic oils for priming coats, has been very well carried out, and has furnished considerable useful information, of which more will be said.

One piece of work that the laboratry has done is worthy of special mention: study of the quality of the many gravels and crushed-stone chips with regard to their serviceability as cover for bituminous treatments.

A special technical commission was appointed in 1930, to formulate methods of trial of those materials most frequently used. This commission has been chiefly interested in tars and asphalts, and has established suitable tests.



PAVED DITCH on road from Rome to Siena. Ditch has walls with weepholes on both sides; guard fence surmounts roadside wall.

Developing rock asphalt

It has already been noted that macadam roads are the mainstay of the Italian system and must continue to be such for some years at least. Surface treatments with asphaltic materials or coal tar have been used with some degree of success. However, there are serious defects that must be eliminated if such treatments are to be continued. The asphalts tend to become unduly slippery for the animal-drawn traffic, and the tars tend to pick up badly on hoofs and on iron tires. Furthermore, Italy has to pay large sums for these materials, since bitumens and pyrobitumens are completely lacking in that country. There is little petroleum. But there are two large deposits of excellent rock asphalt. This material has been extensively used for sheet paving in city streets, not alone in Italy but in other countries as well. There used to be a considerable yardage of Sicilian rock-asphalt pavement in New York City. But paving a city street with a thick sheet of rock asphalt and surface-treating macadam roads with it are two entirely different matters. This is why A.A.S.S. seriously studied the question of the utilization of Italian asphaltic materials, and investigated new and practical methods of application of its own national mineral resources. Furthermore, it desired to eliminate the characteristic faults usually encountered in practice. It has been shown that hot application methods must be abandoned, and that rock asphalt should be applied cold and only as a thin carpet coat.

Space does not permit entering here into a detailed account of the research, and the reader who is interested in it is referred to a booklet issued by A.A.S.S. entitled "Nouveaux Procédés d'Utilisation des Poudres de Roches Asphaltiques pour le Revêtement des Routes." (There is no published English translation.) The outline of the method follows.

Two main deposits are worked. One is in the Abruzzi Mountains, and the other is in southeastern Sicily. They differ widely in characteristics, the former having an asphaltic content of 8 to 20 per cent and the latter of 2 to 10 per cent. After the rock is powdered, some of it is subjected to distillation so that light oils and asphaltic residues are extracted. These materials are combined to produce a mineral oil having such a viscosity that it may be used cold even at low temperatures and will penetrate through the rock powder with which it later comes in contact and cut it back.

The materials used for treating the road surface are powdered rock asphalt containing the proper asphaltic content, the oil just described, and specially hard stone chips or gravel. The steps to be taken are: (1) clean old road surface and prime with mineral oil; (2) spread a light layer of powdered asphalt; (3) spread a layer of stone chips that have been thoroughly coated with oil; (4) roll well; (5) spread a light coat of powdered asphalt; and (6) open to traffic.

This method is based on the manner in which the oil acts on the powdered rock asphalt. The oil has the property of giving to the mass of rock asphalt and stone chips the consistency of a true bituminous conglomerate, having as essential features a minimum of bitumen and a maximum of ruggedness.

As stated by the Italian engineers:

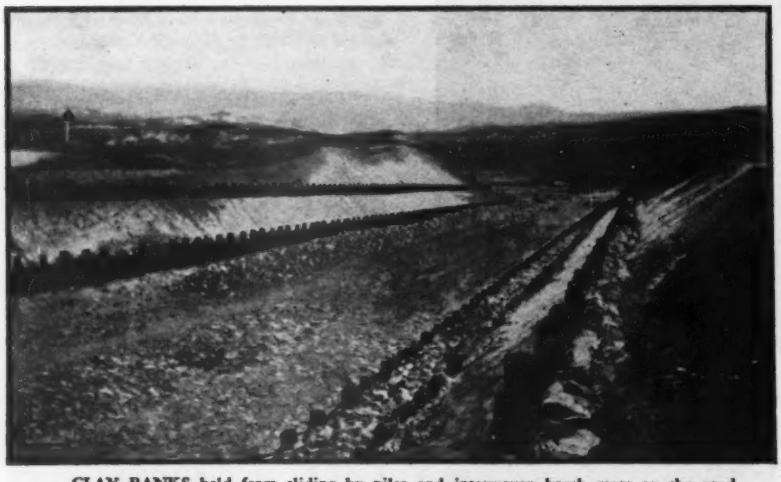
> Because of the light fractions, the oil should accomplish above all its specific function of so cutting back the powdered asphalt as to make it a suitable binder. Because of the heavy fractions it should strengthen the binding qualities of the powder itself by increasing the bitumen

DITCH on the autostrada from Rome to Lido. Note the stone road markers as well as curbs and the trees, light standards and advertising signs in the bordering grass plot.

content in such manner that the ensemble of oil and powdered asphalt shall have the necessary adhesion both to the roadbed and to the crushed stone cover. And finally, because of the middle oil fraction, it provides the treatment with a degree of plasticity that assures the maximum toughness of the mix. . . . Rolling has for its aim the assurance of making the cover penetrate into the mass of rock asphalt, the better to make an unbroken surface, and lastly to make certain the partial evaporation of light oil, and yet increase the binding properties of the bitumen contained in the powdered rock.

The experiments were so successful that in 1934 about 124 miles of the national system were treated, and many more kilometers of old worn surfaces were made non-raveling and skidproof by this method. The writer traveled over many kilometers of this treatment and saw considerable work being done, and he was impressed with the excellence of the surface produced. The customary shiny smooth-to-slick surface produced by the ordinary asphaltic treatment is missing. Instead, there is a mosaic of chips showing through, and the surface is apparently skidproof.

However, the observation must be made that it is possible to introduce a spade or a hoe under the treatment and remove it like a cake from the griddle. This was seen numerous times by the writer. It seems to indicate that there is not the adhesion between the macadam and the treatment that the statement above quoted assures us should exist. On the other hand, there was no sign of this surfacing being picked up on animals' hoofs or on iron tires.



CLAY BANKS held from sliding by piles and interwoven brush mats on the road (under construction) between Siena and Radicofani.

Travel conditions

A motorcar trip over Italian roads and streets is well worth while. The advertisements tell the tourists that he will meet with little motorcar traffic, and this is true. However, nothing is said about all the other kinds of traffic that will be encountered, dodged, slowed down for, horn tooted at, hair stood on end for, worried about, cussed at and wondered at! The Italian pedestrian believes that the center of the country road or the city street or the boulevard was built for his special pleasure and needs. The peasant, driving a team of huge oxen or four horses and an ass in tandem stretching a hundred feet in front of a heavy two-wheeled cart, thinks likewise. So do thousands of bicyclists. So do people driving overladen carts drawn by cows, or dogs, or goats, or bicyclists, or by the women of the family. So do groups of wandering priests making a pilgrimage to Rome. So do the school children who swarm all over the highways at unseemly hours. Even in eternal Rome, where Il Duce has laid out new sidewalks 26½ ft. wide, the noble and the plebeian Romans gallivant down the center of the wide driveways, stop to talk and gesticulate, and pay no attention whatever to motorcars or trucks. Add to this the recent ruling that the motorist must not blow his horn in city limits, and it will be seen that driving a car in the United States is but child's play. It does not matter in what part of Italy you journey, these conditions are the same.

Although there is little pleasure-car traffic except in Rome and Milan, there is a considerable motor-truck traffic in certain parts of Italy, though almost none in others. The trucks are very heavy diesel-engined vehicles, often pulling large trailers. The loaded truck may not exceed 24 metric tons, and most of them reach that limit. They travel fast, blowing out dense clouds of blue-black smoke that sometimes obscures the landscape. It was noticeable that these trucks operate only on those sections of highway that are fairly level, such as from Trieste to Venice, or Venice to Milan via Padua. It was to be observed, too, that in the mountainous regions (and the whole backbone of Italy is high mountains) there was almost no motor traffic.

On the 85-mile route from Bologna to Florence the land rises abruptly, much as the Rocky Mountains rise west of Denver. In ten miles the road rises from close to sea level to a height of 3,200 ft., or at 6 per cent average grade. But there are many sudden down grades as well, so that many of the succeeding abrupt rises are from 12 to 15 per cent. There were but two tangents as long as 100 yd. Very sharp curves on steep grades are the rule. Retaining walls are built prodigally of beautiful cut stone—miles and miles of them. The scenery is wild. There are few habitations except in the small walled-in mountain towns along the route. The roadway is mostly surface-treated macadam in perfect condition. This is the only road between these two large cities. On a trip made in March, 1935, between 1 and 4 p.m. only two pleasure cars and one small truck were passed, and two small cars were noted going in the same direction as the writer. Inquiry at headquarters revealed the fact that this was not unusual but rather an average condition. However, the road was rather well cluttered up with pedestrians, cyclists, oxen, mules, horses, dogs, goats, milk cows as draft animals, and children.

This one route is cited solely as an example of what is to be found all through Italy where there are mountains to be climbed. Gasoline is very expensive, averaging, with the 60c. dollar exchange, about 65c. per gallon. Oil is likewise expensive. The government tax is nearly 50 per cent. As already noted, Italy has no oil wells and must import all motor fuel and lubricants.

Wherever one wishes to drive over the national system he will find perfectly kept roads. But he will do well not to venture on the provincial or the communal systems, lest he find just as poor excuses for highways as many of our own counties and townships exhibit. The national roads are patrolled by maintenance men who are always on the job. These roads are kept scrupulously clean. Even the untreated macadam roads are swept like city streets, and all manure and other filth is removed daily.

But, though the roads are perfectly kept, they are far from being perfect as the A.A.S.S. knows only too well. The alignment of most of them is worse than faulty; it is dangerous. If there ever comes a time when Italy is as motor-minded as the United States, then the accident roll will make our present record seem insignificant. Some of the curves on the principal routes are so abrupt that a large car must reduce speed to 5 m.p.h. to drive them safely. On one stretch of road from La Spezia to Genoa the writer averaged but 15 m.p.h. for three hours and succeeded in raisng calluses on his hands from the incessant turning of the steering wheel. On this particular mountainous road

two trucks were sighted, both unable to make the grade. No other motor vehicle was seen during that time, and yet this is the main route from Pisa to Genoa on the west coast.

Autostrada provide speedways

To overcome these difficulties, Italy has introduced special motor roads known as autostrada, of which she is justly proud. The first to be built was from Milan to the lakes in 1925. Since then seven others have been opened, and the original has been amplified. In time there will be an autostrada from Turin to Fiume, along the foot of the Alps. Some of it has already been completed; the sections from Milan to Brescia via Bergamo, from Milan to Turin, and from Padua to Venice are open to traffic. The highway from Mestre (Venice) to Trieste is really the same as an autostrada, except that all sorts of traffic are permitted. Another important section is that from Florence to the sea, at Vareggio. The Naples-Pompeii section and Rome-Lido sections have been in operation for some time. The total length is about 270 miles.

Some of these express roads are free, while others are toll roads. On the toll roads the motorist comes to the toll gate, where he is most courteously addressed by the gate-keeper, who asks him where he is going and whether he is returning. A ticket is given him, stamped and punched to indicate the date, time and points of entrance to and departure from the autostrada. There is a heavy fine, and perhaps imprisonment, if the motorist tries to go farther than he pays for. Should he decide to extend his trip, he must stop at the toll gate along the way to which he has paid his toll and buy there another ticket to his destination. Since the driver cannot leave the autostrada without stopping at a gate and delivering his ticket, there is no way that the unscrupulous can beat the game. Each toll gate is connected with all of the others by telephone. There are no traffic policemen. The toll-gate keeper sells several brands of gasoline, as well as oil and sundries. Tire repairs are made at some stations, and emergency repair trucks were seen at a few gates. The gate-keeper is in uniform, and all of them that were encountered were most efficient and well informed about road conditions and routes to follow. A round-trip ticket is cheaper than two one-way tickets.

In general, the government sells the concession for an autostrada to a private company. The company, with a subsidy from the state, must finance, build and operate the toll road under state supervision. The concession lasts for 50 years, after which the state takes it over. Each agreement contains rules and regulations concerning financing, management, operation after construction, eventual purchase, and special privileges accorded by the state beyond the general laws.

ENTRANCE to towns commonly bottlenecked as shown by old city gate to Siena, which it is apparent will pass only one automobile at a time.

The autostrada very much resemble the drives of the Westchester County Park system, New York. There are no grade-crossings with either highways or railways. The pavement is from 26½ to 33 ft. wide, in general, although the Milan-to-the-Lakes autostrada is 46 ft. wide (including shoulders). Grades are usually less than 3 per cent. Vertical curves at breaks in grade are sufficiently long to provide adequate sight distance. Alignment is excellent; very long tangents are connected by curves of long radius suitably banked. Connection is made with other through routes at important intersections, but the autostrada enter no cities or town directly. On the Brescia-Bergamo line there is a cloverleaf intersection designed on American model, said to be the only one of this kind in Europe.

Bridges carrying traffic over the autostrada are generally of sufficient span to permit of the autostrada's pavements being widened when necessary. Where the autostrada pass over canals, the latter's walls have been designed and built to take care of future improvements. Italy has many canals and wide irrigation ditches of great importance, so that such crossings are numerous.

Tunnels are not uncommon on some of the routes. On the Trieste-Venice highway many are encountered. They are well designed and wide enough to encourage the motorist to stay on his own side of the pavement rather than to drive along the center line. Most of the tunnels are short and free from curves, although some sharp curves were found just outside.

The pavements are either portland cement concrete about 8 in. thick, or asphaltic concrete on a telford base. The portland cement concrete is usually surface-treated with tar or asphalt emulsion to relieve the glare of the bright Italian sun. Wherever settlement occurs, the surface is brought to grade with a cold coal-tar mix, which may be as thick as 4 in. Mud-jacking was not seen, and apparently has not been tried. The blacktop patching was not well done.

Common design hazards

There is usually a grass or a gravel shoulder about 3 ft. wide on each side of the pavement. There may be a concrete curb or not. But in many sections cut-stone markers are placed at about 33-ft. intervals along the edges, whether there is a curb or not, projecting above the pavement. They are very white and show up well at night—though there is little night driving—but they are extremely dangerous. If an automobile traveling at high speed should deviate ever so slightly from the pavement, a disaster would be certain. The shoulders are narrow, and at their outer edges are deep ditches, often paved, while along the shoulders are many trees, signs and perhaps light standards. The reader may judge what his feelings might be when driving along such a highway at high speed, knowing that if he should, accidentally hit a stone marker his front tire would explode, his car would be thrown out of control from the impact, and a ditch, tree or post would suddenly stop all further progress.

Trees should not be planted on these narrow shoulders. The deep ditches are unnecessary and should not be so close to the traveled way. The stone markers are an abomination. They are used on the national roads as well as on the autostrada. Perhaps if they were removed, the Italian ox-cart driver, the pedestrians and others who travel on the roads might take to the sides instead of the center.

On the autostrada from Rome to Ostia (Rome-Lido) some very objectionable advertising signs are permitted and encouraged; they are erected on posts that are immediately adjacent to the pavement, and they not only detract from the beauty of the drive but are a constant source of danger. This autostrada is rather too brilliantly lighted at night. The lights are close together, mounted on poles near the edges of the pavement. The center of the roadway is not well illuminated.

A bad feature of many Italian roads is the paved deep ditch. It is poorly designed from the motorist's standpoint. The massive stone walls on either side sometimes extend for miles.

The national roads

As has been stated, Italy's national roads are good. They are for the most part from 19 to 26 ft. wide between

shoulders. On the 10,000 km. of improved and rebuilt sections the surfacing is about on a par with American standards. They are clean and wonderfully well maintained. They are mostly macadam on a very thick telford base. In some instances it was observed that the total depth from subsoil to top was as much as 2 ft.

Tars and asphalts are used for surface treatments or carpet coats. The writer was told that whichever was the cheaper and met the requirements was used. There seemed to be a considerable leaning toward asphalt emulsion for maintenance. It was said that the men could use such material irrespective of weather conditions, and sunny Italy does have a rainy season, as well as very cold winter weather.

But the American tourist finds fault with several things. First of all is the matter of alignment. This may vary from good to maddening. The ordinary road map never could begin to show all of the miraculous turns and twists of some of the mountain highways. Even the plains roads may exhibit a wholly unexpected kinkiness. On American roads we bank the curves, and steering is not difficult. But in Italy this cannot be done because most of the traffic is slow-moving oxen, horses or cows, and if the sharp turns were sufficienty superelevated for cars traveling 45 m.p.h. then the animals would lose their footing and the loaded wagons would slide where they were not expected to. The American highway engineer who was practicing prior to 1920 knows the opposition that horse-owners' associations made to banking curves. One very successful road supervisor in the early days in New York State used to solve the problem by taking the belligerent horseman for an automobile trip, indicating to him gently that everyone would be better .off if motor trucks were used. But that would be a different story in Italy. The ox-cart is there for another century. Hence, curves properly banked for fast motorcar traffic will not be found except on the autostrada. Another source of complaint is one that is common at home, namely that the state highway improvement stops short at the city gates, and that the streets in town are far from perfect. But, as here, the highways are being built around the towns.

Roadside beautification

If the highway official wishes to see to what extent roadsides may be beautified, he could do no better than to take a trip through the Italian Riviera. The drive from Genoa to the border of France at Ventimilia along the Mediterranean Sea is one of sheer loveliness and charm. Bridges, culverts and retaining walls are tastefully and artistically built. A wealth of flowers adorns the picture, and Italy may point with pride to her achievement. Another delightful drive is from Trieste to Venice. These highways should set the style for other lands to follow.

Italy, strange to say, is not a land of trees, because the old forests have been cut down for kindling wood. In one of the government publications the statement is made that the highways are being tree-lined for the double purpose of affording shade in summer to the many pedestrians and animals and to instill in the Italian mind a proper respect for and love of trees! But the motorist sees this tree planting as a dangerous nuisance, for the trees are planted near the pavement, they are too close together, and at night they are likely to cause accidents. Germany has done the same sort of planting, and when an auto accident is noted in the newspaper it generally ends with the statement that the dead driver ran his car into a tree.

Tree planting is being carried on in a wholesale fashion. The figures available show that 757,000 trees have been planted, and if one dies a new one is substituted. No objection would be forthcoming if only they had been planted sufficiently far from the pavement to prevent accidents.

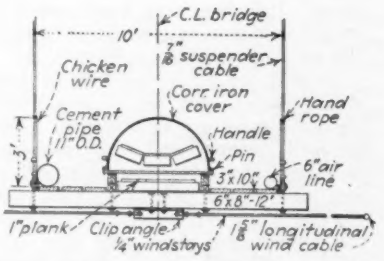
The reader may impatiently ask: if these grave defects exist, why do we hear so little of motorcar accidents in Italy? The answer is that there is little motorcar traffic. But if and when Italy motorizes itself, then the toll of human life will be tremendous, unless steps are taken to improve conditions. The writer saw six serious accidents in two weeks that could not have happened on our own roads.

The autostrada is the ultimate answer to Italy's problem of motor transportation. A great start has been made, and if only there are enough motor vehicles used to make the building of these motor roads financially worth while, Italy should soon possess a network that will make her noteworthy.

Two 1,437-Ft. Suspension Spans for Aggregate Belt at Coulee Dam

Unusual means of transporting aggregate across Columbia River to west concrete-mixing plant fits in well with extensive use of belt conveyors on this job

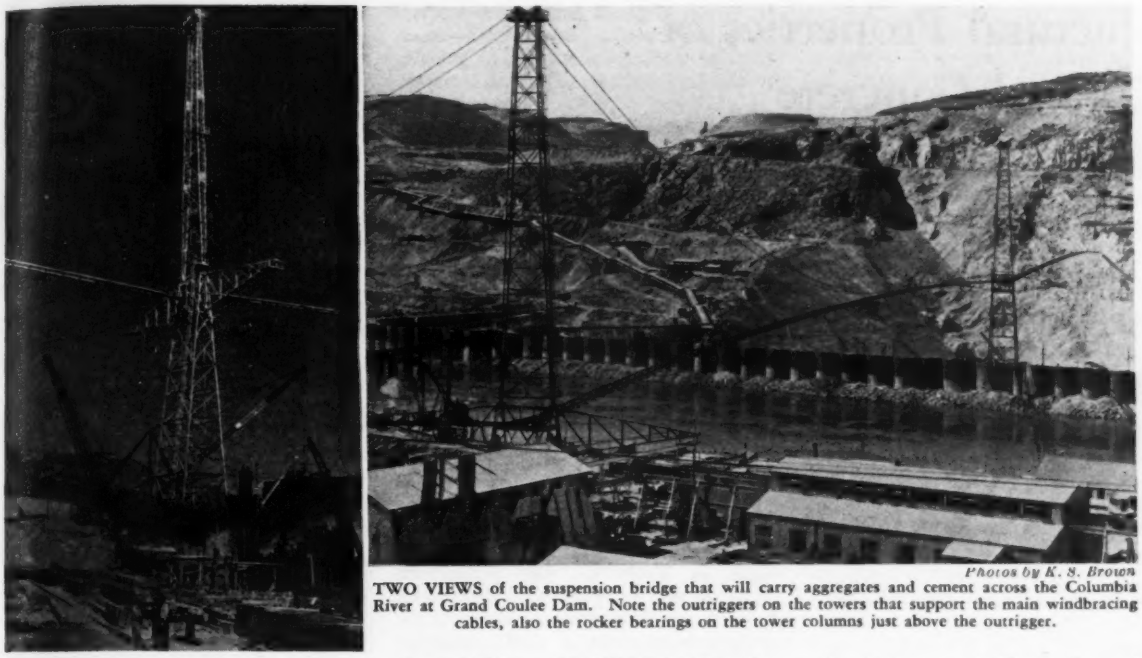
AGGREGATE in large quantities—some 4,000,000 tons of it—must be moved across the Columbia River to supply the concrete-mixing plant on the west side of the river (the "west-mix plant") recently built to provide concrete for the westerly portion of Grand Coulee Dam. The present contract calls for about 4,500,000 cu.yd. of concrete. Aggregate for this concrete has been developed in deposits on the east bank of the river, but as concrete-mixing plants are to be on both sides of the stream the delivery to the west bank calls for transporting the aggregate across the river by some means. Final choice of method of crossing the river, based on economy, speed of operation and convenience in changing from one kind of material to another was for a conveyor belt; it was found feasible to support a belt of suitable capacity on a suspension bridge with two spans of 1,437 ft. The loadings, capacities and methods of constructing the bridge are outlined in the following.



BELT and floor-system details of the suspension bridge.

The major requirement was that the bridge should be capable of carrying 400 lb. per linear-foot, and at the same time withstand the winds that sometimes sweep up and down the canyon. The design provides for a full load of aggregate on a 36-in. belt, a loaded 11-in. cement delivery pipe, a man standing in every 10-ft. panel for full length of the span, snow, ice and wind loadings. With a speed of 400 ft. per minute, the capacity of the belt is rated as 700 tons per hour.

Weight economy suggested the use of a pair of cables over each saddle instead of a single line of larger diameter. Thus the spans are made with two pairs of 2¼-in. plow-steel cables, from which suspenders are hung every 10 ft. Each pair of suspenders carries a 6x8-in. floorbeam. The plan of construction was to hoist as a unit a pair of suspenders with floorbeam attached. The suspenders were fastened simultaneously by workmen to both of the main cable pairs, and with floorbeams thus supported it



Photos by K. S. Brown

TWO VIEWS of the suspension bridge that will carry aggregates and cement across the Columbia River at Grand Coulee Dam. Note the outriggers on the towers that support the main windbracing cables, also the rocker bearings on the tower columns just above the outrigger.

only remained to place the stringers and advance the floor system from the bank toward midstream, making connections and fastenings as the work progressed.

The transverse spacing between main cable pairs at the tower tops is 10 ft. The bridge-floor width is 10 ft., allowing space for a walkway on either side of the centrally located 36-in. troughing conveyor. Details of walkway construction are shown by the accompanying drawing. The floor system has a sliding joint in each span to accommodate changes in length caused by variations of the vertical deflection. Changes in length of the conveyor belt resulting from variations in loadings and consequent different sags are compensated for by gravity take-ups.

By using the cofferdam as a support for the central tower, which stands between the two main spans, it was possible to split up the crossing into the two equal 1,437-ft. spans. The height of the towers above the floor is 175 ft.; the total height of the central tower is 325 ft. Each of the towers has a 5-in. pin connection near the floor level; above that point it is a rocker tower of four 8x8x1⅛-in. angles arranged to form a narrow rectangular section with maximum horizontal dimensions 5x20 ft.

The anchorages differ materially. The west approach span is only 124 ft. long and terminates in a cluster of 56 round anchor rods 1½ in. in diameter, grouted into holes drilled 20 ft. into the rock. A block of 165 cu.yd. of concrete cast around these rods and the anchor pin grillage forms the west anchorage. At the east end the approach span is 510 ft. long and terminates in a gravity anchorage consisting of a 300-cu.yd. block of concrete.

The spans were designed for a camber of 10 ft. under full load. More than this appears in the accompanying picture because it does not show the spans loaded. Pivoted outriggers were placed on each of the rocker towers to get the desired spread in the windbracing cables; these cables, 1⅜ in. in diameter, are tied to the floor system by a stay rope hitched to a clip angle or fin bolted to the under side of each floorbeam. A turnbuckle is provided in each wind stay to adjust the tension. The windbracing systems terminate in a separate anchorage on the west end of the bridge, but on the east end attach to anchorbolts in the main gravity anchorage.

Erection of the cables was simplified by paint marks placed on all cables at the factory, to indicate the points at which connections were to be made. This greatly facilitated the attachment of hangers to the main cables of the suspension span and also aided the attachment of cross-hangers to the windbracing cables.

The bridge is part of the construction equipment assembled by the M.W.A.K. Co., general contractors on the Grand Coulee Dam. The general contract for the suspension bridge was held by the Columbia Steel Co.; the bridge was designed and manufactured by the American Steel & Wire Co. Erection was by construction forces of the M.W.A.K. Co., operating under direction of H. L. Myer, general manager.

Dangerous Work Necessary in Mapping Colorado River

THE aerial surveying of the Colorado River above Boulder Dam which is being made to secure maps that will aid in studying silt deposition in the reservoir involves the difficult feat of securing accurate ground-control points, so that the photographs may be fitted exactly into the complete mosaic from which the maps are made.

The Colorado River Canyon presents exceptionally difficult conditions for the establishment of control points. A survey party of twelve men from the Soil Conservation Service and the Fairchild Aerial Surveys, Inc., has started downstream in four sturdily constructed boats; until they reach the headwaters of Boulder Reservoir there is no way for them to turn back or leave the river, and food and equipment for eight weeks have been taken along. Other parties that have traversed the section have made only reconnaissance surveys; this is to be the first accurate survey, and as a result the instruments are more numerous, bulky and precise.

The aerial cemera that was used is a four-lens instrument that has been used successfully on other aerial surveys and in some measure makes necessary fewer ground-control points than would otherwise be the case. On the other hand, a total of 250 points must be established; and in the rapids of the river and the steep walls of the canyon (overhanging in a number of places) this undertaking is one of the most difficult on record. The party is making about 1 mile a day.

E. A. Schuch is chief photogrammetric engineer for the Soil Conservation Service. F. H. Woody has charge of the Fairchild engineers. Other members of the engineering staff are W. B. Wisenand, Newton Miller and Clyde Wainwright. J. Smith is radio operator and W. Yates guide.

Structural Properties of Vibrated Concrete

Tests demonstrate possible savings in cement and reduction in concrete shrinkage by use of vibration as an aid to placing

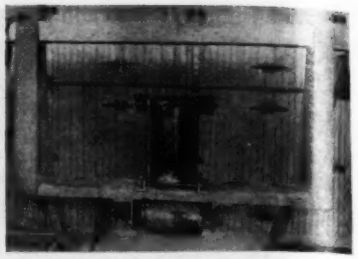
By Paul Anderson
Balboa Heights, Panama Canal Zone

THE TIME is past when the most reliable concrete is considered that which has a high cement content, and many specifications no longer mention the proportions of cement and aggregates but discreetly leave that to the manufacturer. The reason for this change is that it has been realized that in certain coarse aggregates nature has provided us with thoroughly aged concretes, which have long since lost the properties of shrinkage and flow and acquired a high ultimate strength. Bearing this in mind, it is seen that not only the most economical but also the most structurally desirable concrete is produced by using large proportions of coarse aggregate and providing just enough mortar to weld together closely placed lumps of aggregate in such a way that voids are reduced to a minimum.

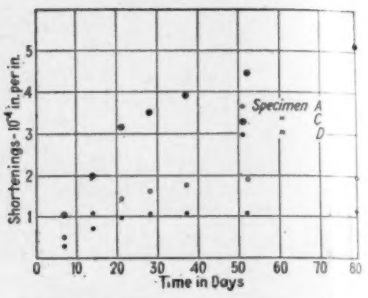
Placing the concrete with the aid of vibration affords a means of compacting mixtures with large amounts of coarse aggregate and has in recent years been used with much success. In the following are presented the results of research work done by the writer while on the teaching staff of the University of Minnesota. Acknowledgment is due Prof. C. A. Hughes of the civil engineering department of the University of Minnesota for much help and advice.

The concrete mixtures, which were compared for structural properties, are listed in Table I. The proportions 1 : 2½ : 4½ and 1 : 2½ : 7½ were determined by trial as the mixtures which (with the water-cement ratio of 0.45) could be manufactured into dense concretes by ordinary tamping and vibration respectively. Further additions of coarse aggregate were found to result in specimens containing air pockets and honeycombing.

In order to have a common yardstick for the influence on shrinkage and ultimate strength of the different amounts of coarse aggregate, specimens of 1 : 2½ mortar were made with the same water-cement ratio.



VIBRATING TABLE with mold in place for producing a test cylinder.



TYPICAL shrinkage results show much smaller values for the vibrated concrete D, over both the mortar C and the tamped concrete A.

TABLE I—CONCRETE MIXTURES USED IN TESTS

Mark	Method of Placing	Make-Up by Dry Weight	Water-Cement Ratio, by Weight	Type of Coarse Aggregate
A, A1	Tamping	1:2½:4½	0.45	Gravel
B, B1	Tamping	1:2½:4½	0.45	Limestone
C, C1	Tamping	1:2½	0.45	
D, D1	Vibration	1:2½:7½	0.45	Gravel
E, E1	Vibration	1:2½:7½	0.45	Limestone

TABLE II—COMPRESSIVE STRENGTH OF CONCRETE

(Average of Two Cylinders, Lb. per Sq. In.)

w/c Ratio	0.45 by weight = 5.07 gal. per sack				
Compacted by	Vibration		Tamping		Tamping
Slump	0		¼		6
Mix by Dry Weight	1:2½:7½		1:2½:4½		1:2½
No. of Sacks Cement per Cu. Yd.	4.0		5.32		10.56
Coarse Aggregate	Gravel	Limestone	Gravel	Limestone	None
Age, Days					
14	5,410	5,310	5,450	5,110	4,790
21	5,790	5,530	5,540	4,810	5,160
27	5,610	5,420	6,480	5,660	5,250
35	6,160	6,320	6,610	4,910	5,530
42	6,240	6,500	6,540	6,440	6,000
Average	5,860	5,820	6,120	5,390	5,350

TABLE III—SHORTENING OF 4x6x21-IN. PRISMS

10⁻⁴ In. Per In.

Mark	Mix	Method of Placing	Time in Days						
			7	14	21	28	37	52	80
A	1:2½:4½	Tamping	51	107	142	160	175	187	195
B	1:2½:4½	Tamping	64	125	163	176	182	180	193
C	1:2½	Tamping	104	200	315	349	389	443	515
D	1:2½:7½	Vibration	28	70	98	104	106	105	116
E	1:2½:7½	Vibration	21	72	101	112	110	115	118
A1	1:2½:4½	Tamping	55	110	141	149	169	174	197
B1	1:2½:4½	Tamping	66	121	157	166	186	189	202
C1	1:2½	Tamping	154	260	345	385	426	475	545
D1	1:2½:7½	Vibration	34	59	94	99	99	102	109
E1	1:2½:7½	Vibration	34	69	98	100	106	104	104

Specimens and apparatus

A high-early-strength cement was used: the fine and coarse aggregates were from local sources. The type of the coarse aggregate is given in Table II. The sand had an average fineness modulus of 2.95, and the grading of the gravel and limestone coarse aggregate was as follows:

Size	Percentage
1½ to 1 in.	38
1 to ¾ in.	38
¾ in. to No. 4	24

The concrete was mixed by hand. All the mixtures except the plain mortar showed a slump of practically zero. Concrete placed by tamping utilized standard A.S.T.M. procedure. For the other concrete a vibrating table made by the Electric Tamping Co., of Ludington, Mich., was used. It consisted of a wooden table suspended by double leather straps from a wooden beam as shown in the accompanying photo. An electric motor with an unbalanced wheel, supported underneath the table, produced 3,500 vibrations per minute.

Two types of specimens were made, 6x12-in. cylinders for testing ultimate strength, and rectangular pieces 4x6x21 in. for shrinkage measurements. A 10-in. Whittemore strain gage was used for measuring shortenings, and four different gages were used on each specimen; the average was then computed.

The compressive strengths of the cylinders at various ages are listed in Table

II, and indicate that the water-cement ratio law may be depended on for mixtures containing very small amounts of cement.

Table III gives the shortenings of the specimens due to shrinkage. The readings for three test pieces representative of unrestrained mortar (C), tamped concrete (A) and vibrated concrete (D) are plotted in the accompanying figure. It is apparent that the decrease in cement-paste content made possible by placing by vibration results in material reductions of the contractions due to loss of water.

The test results suggest the following:

1. The water-cement ratio law appears to hold for very lean mixtures as long as a compact concrete can be produced.

2. The shrinkage of lean mixtures when compacted by vibration is considerably less than for richer mixtures of the same water-cement ratio.

It follows from the above conclusions that if shrinkage is an undesirable property in a building material, then the vibrated concrete of low cement content is superior to the tamped concrete of higher cement content.

Remarkable Series of Bridges on Oregon Coast Highway

Five structures under construction include concrete deck arches and girders, concrete bowstrings and steel cantilever, with interesting design and erection features

By Conde B. McCullough
Formerly Assistant State Highway Engineer of Oregon

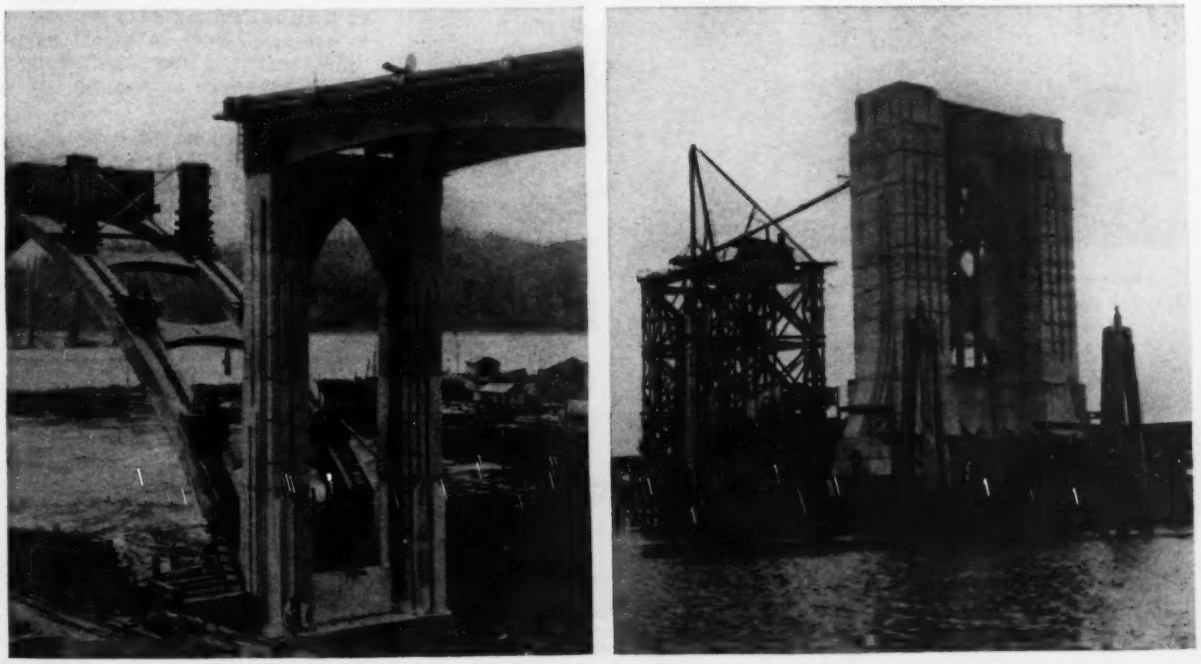
THE most ambitious bridge-building program ever undertaken by the state of Oregon is well under way along the Coast Highway. It is estimated that three of the five structures in the program will be ready for traffic early in 1936 and that the other two will be complete by September of that year. The bridges, financed by PWA on the basis of toll refunding (*ENR*, June 6, 1935, p. 814), are shown in Fig. 2. A number of interesting design and construction features are involved which may be outlined briefly.

Construction Hinges—On all of the concrete deck arch spans temporary construction hinges of the Considere type are being used. This expedient results in a marked decrease in deformation stresses with a consequent saving in section. Fig. 3, showing one of the arch spans comprising the south approach to the Coos Bay Bridge, indicates the location of the skewback and crown hinges.

Concrete Bowstring Arches—The concrete bowstring arches in the Siuslaw River Bridge, the Umpqua River Bridge and Alsea Bay Bridge make use of structural-steel compression stubs and fabricated-steel tension ties, as shown in Fig. 4 for one of the spans of the Umpqua River Bridge. The compression stubs extend from the skewback pin 8 ft. up into the arch rib. They are designed in the form of a box section with suitable angle lugs proportioned to transmit the entire arch rib compression into the steel hinge pin and then into the tension bar. The skewback hinge pin and the entire tension-tie system will be encased in concrete so that the hinge will no longer act as such. The pinned arrangement was selected in order to insure complete and positive transmission of stress into the arch rib tie.

Steel Cantilever Erection—When the Rogue River Bridge (*ENR*, Nov. 26, 1931, p. 841) was constructed, the state of Oregon purchased a complete set of specially designed hydraulic jacks to be used in connection with the Freyssinet method of decentering employed for that structure. This equipment is being utilized to considerable advantage in the erection of the Coos Bay cantilever bridge, which has a main span of 793 ft. and anchor spans of 457½ ft. The erection procedure is as follows:

FIG. 1—ARCHITECTURAL treatment on Coos Bay Bridge, showing intermediate piers (left) and main channel pier (right).

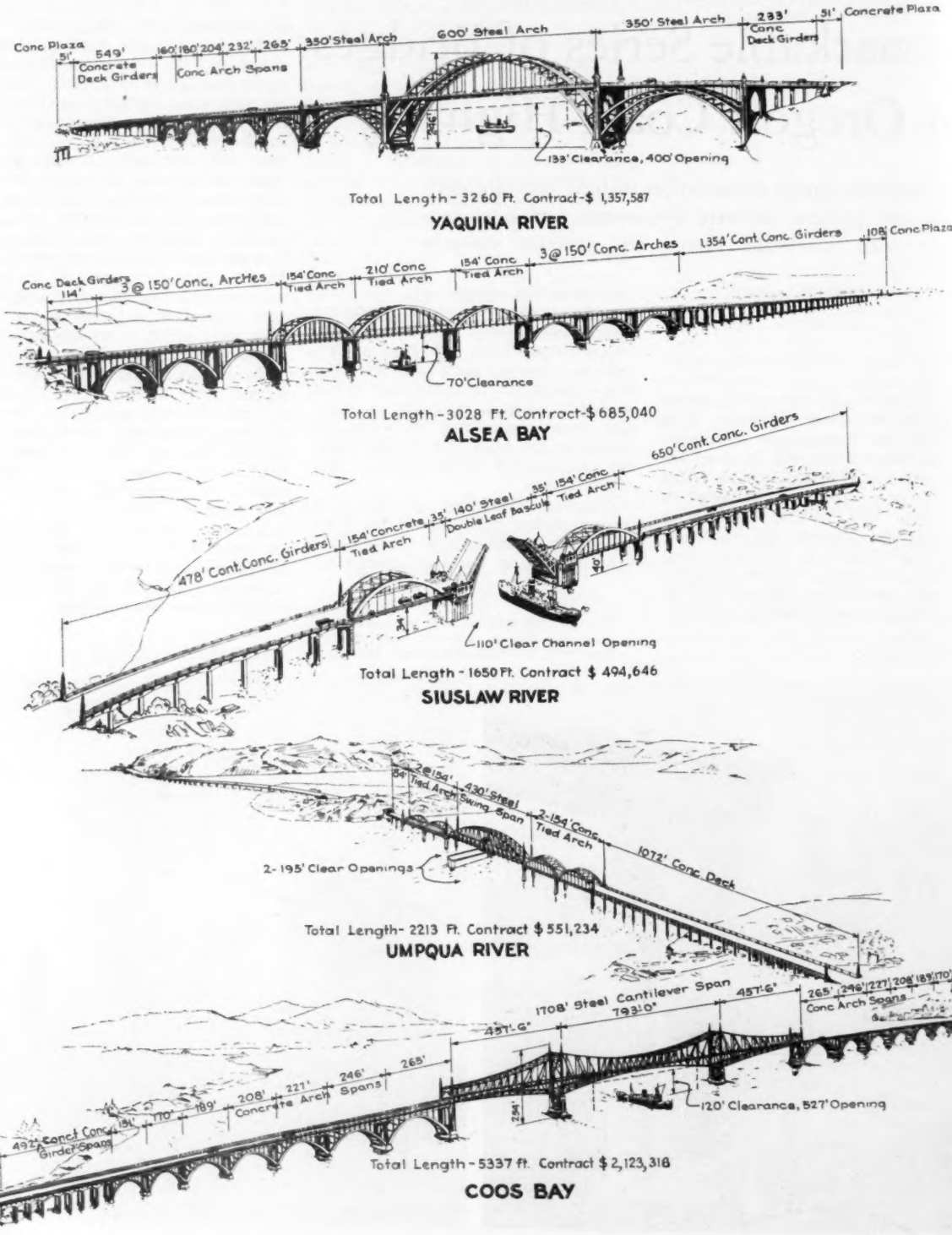


The main tower at the south end of the channel span was first erected to an elevation slightly above deck level by means of guy derricks. One bent of falsework was next placed under the second panel point toward shore as shown in Fig. 5.

The bottom-chord diagonals and deck system were then erected out to this point, and the guy derricks were moved up to deck level. The main tower was next completed, following which erection proceeded simultaneously on both the cantilever and anchor arms. With this method of erection the load must be balanced about the main pier with a slight excess at all times on the anchor arm, and it was in this connection that the hydraulic-jacking equipment was utilized.

Two 275-ton jacks, equipped with accurate pressure gages were placed under each truss on top of the shoreward falsework bent. By means of this equipment the excess load on the anchor arm was very accurately controlled. Erection proceded by cantilevering both ways

FIG. 2—FIVE LARGE BRIDGES UNDER CONSTRUCTION ON THE OREGON COAST HIGHWAY.



until the anchor arm was 275½ ft. from the main pier, at which point a second bent of falsework was placed, also provided with a battery of two hydraulic jacks under each truss. The anchor arm was then completed by cantilevering beyond this support until the end pier was reached. At the same time the cantilever arm was extended out to its junction with the suspended truss without the use of falsework. The same procedure will be followed for the north half of the structure.

Pier Architecture—The Coast Highway bridges are so tied in with the constructure of adjacent state parks that the underneath portions will be subjected to view to a much greater extent than otherwise. For this reason, considerable attention was paid to architectural treatment of the piers (Fig. 1).

Vibrated Concrete—Internal vibrators are being used to aid in the placement of all concrete. On four of the jobs electrically driven vibrators are being used, while the fifth is equipped with air-driven machines. Two types of electric vibrators have been employed, the first being a comparatively light machine equipped with a rigid tube containing an eccentric shaft directly connected to the motor; the second vibrator is a heavier machine in which the motor is connected by a flexible shaft to the vibrating element. Both of these types have given excellent service, the second type being peculiarly adaptable to beams where the distance from the top of the form to the bottom of the concrete is not greater than the length of the machine. The air-driven vibrator has also given very satisfactory service.

A marked improvement in concrete quality has been observed throughout the progress of the work. Gravel pockets have been practically eliminated, and by permitting the use of a stiff dry concrete there has been effected an average saving of about one sack of cement per cubic yard of concrete without any decrease in strength.

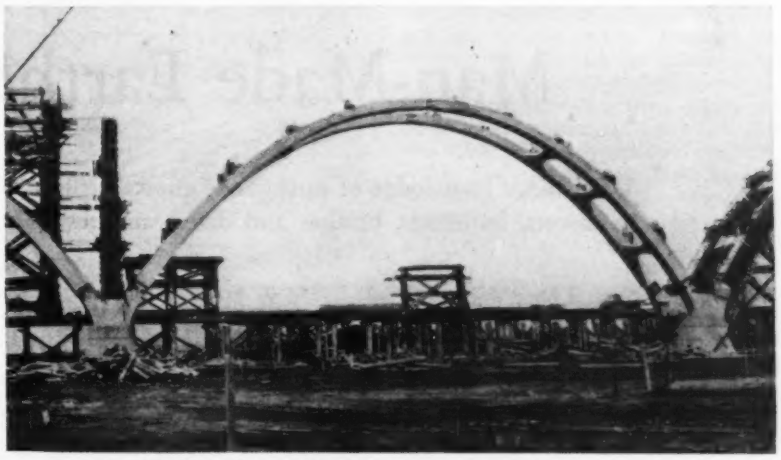
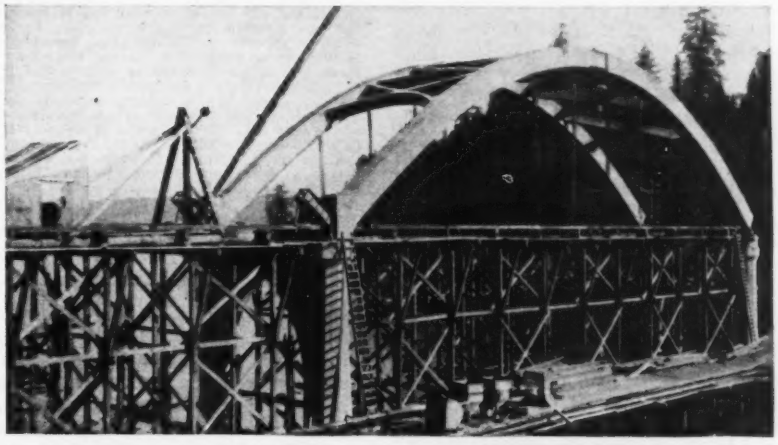
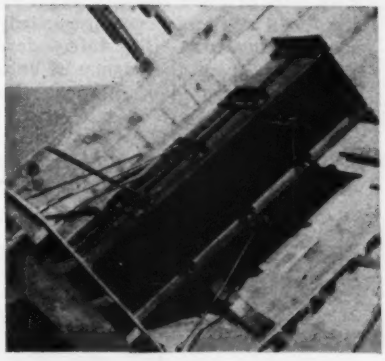


FIG. 3—TEMPORARY HINGES of Considere type at skewback and crown are used on all concrete deck arches.





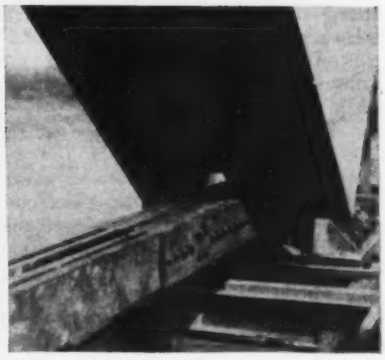
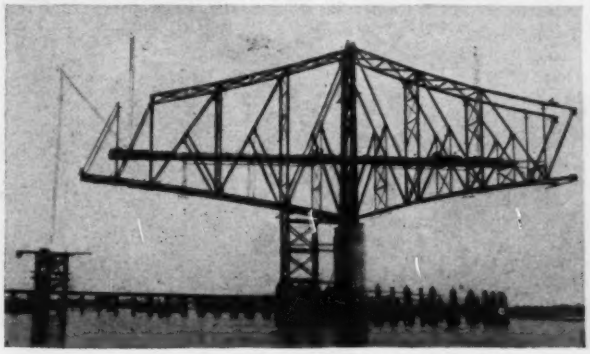


FIG. 4—BOWSTRING ARCHES (right) of concrete incorporate steel compression stubs at the skewback, pin-connected to steel tension ties. In the completed bridge the pinned connection is concreted in, to eliminate hinge action.



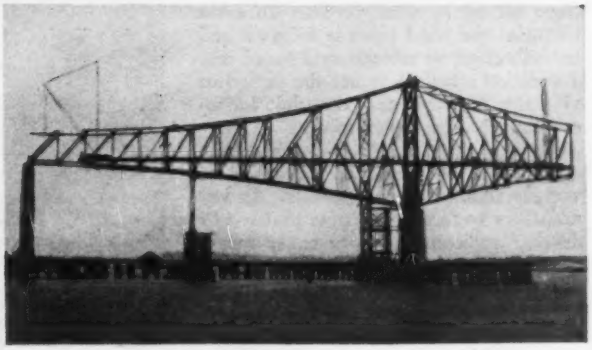


FIG. 5—TWO STAGES of balanced erection of cantilever bridge using two falsework bents equipped with hydraulic jacks under the anchor span.

Man-Made Earthquakes

To advance knowledge of earthquake effects, artificial oscillations are imparted to towers, buildings, bridges and dams, and resultant motions are measured

By Franklin P. Ulrich
Chief, California Seismological Program, U. S. Coast and Geodetic Survey, San Francisco, Calif.

PROGRESS in protection against earthquake destruction has heretofore been seriously hampered by lack of precise knowledge of how the oscillatory shocks exerted by earthquakes affect buildings and other human structures. Only limited conclusions can be drawn from the observation of wrecking or damage of such structures in actual earthquakes. While seismograph records of ground movements in an earthquake are extending our knowledge of the forces that may be exerted at the foundation, far too little is known of the dynamic behavior of structures to permit of tracing the effect of these forces, or discovering where and how a structure should be made stronger. To answer some of the principal questions in this field is the purpose of the studies described by Mr. Ulrich in the present article. Briefly, the building, dam or bridge is shaken by a rotary vibrator, whose force action and frequency are precisely known, and the motions which it produces in the structure are simultaneously traced by a recording seismograph. Continuation of this important research program promises to point the way to increased earthquake safety. —EDITOR.

THE VALUE of knowledge about earthquake effects on human structures has become more apparent as attention has been focused on earthquake-resistant construction. In one state, at least, there are laws requiring certain provisions in design and construction expressly for resisting horizontal forces. Thus there has arisen urgent need for fundamental information on this subject not yet available, nor easy to get. The challenge was taken up by the U. S. Coast and Geodetic Survey, which in 1931 undertook a program of strong-motion seismological investigations in California.

California was selected as the laboratory because of the relatively frequent occurrence of earthquakes there combined with a concentration of population and large buildings. But it was early realized that the newly designed strong-motion instruments alone would not furnish all the needed information. It was necessary to know how various types of buildings vibrate during an earthquake and also something about how they vibrate under the action of other forces. Study of forced structural vibrations was therefore taken up. Results of early strong-motion earthquake observations were reported two years ago in an article on accelerograph records of the Long Beach earthquake (*ENR*, June 22, 1933, p. 804).

Wind vibrations and forced vibrations

For the study of structural vibrations, suitable instruments were developed and installed. Up to May 1, 1935, vibration observations had been made in about 300 structures—buildings, dams, bridges, bridge piers, water tanks and others. In practically all of these tests the effects measured were those caused by vibrations set up by wind forces. In some localities the wind force is so small and the vibration so minute that there was a question whether or not the period of vibration would remain the same for an earthquake or a larger force.

To meet this difficulty, a machine was constructed for setting up vibrations of various amplitudes and periods. It was necessary to have a machine that would develop sufficient force to cause measurable vibrations in structures and yet would be light and small enough so that it could be used and moved easily and could be set up in buildings. A period range of 0.1 to 1.0 sec. was desirable.

This vibrating machine (Fig. 1) was designed by Prof. L. S. Jacobsen, of Stanford University, and John A. Blume, then a graduate student in structural engineering. The machine, constructed in the machine shops at Stanford University by Mr. Blume, consists essentially of three rotating 30-in. steel disks to which lead plates are bolted to produce unbalance. The forces developed depend upon the amount of unbalance and the speed of rotation. Two of the steel disks are on a lower shaft, and the third is on a second shaft directly above. The amount of unbalance on the upper disk is equal to the amount on the two lower disks combined. The positions of the weights on the disks are so arranged that only horizontal forces are developed, the vertical force of the top disk balancing the vertical forces of the two lower ones.

How the vibrator is operated

Fig. 2 shows the forces developed with different weights at different speeds. Each lead plate provides 48 in.-lb. of unbalanced moment, and these curves are derived from the formula

$$F = \frac{Wr\omega^2}{6}$$

where F = centrifugal force, in pounds, W = weight of unbalance, in pounds, r = radius from center of rotation to center of gravity of unbalance, in inches, ω = angular velocity, in radians per second, and g = acceleration of gravity, in inches per second per second.

In operating the vibrator, it is usually set up on a top floor of the building and is ballasted, bolted to the floor, or securely braced horizontally between solid wall or columns, using 4x4-in. timbers and jackscrews, which are part of the machine. Then the disks are speeded up to about 600 r.p.m. and the belt is thrown off; the machine runs from 3 to 6 min. before coming to rest. The vibration meter and recorder are started before the belt is thrown off, so that a record of the vibrations is secured. As the machine slows down, it usually passes through various natural periods

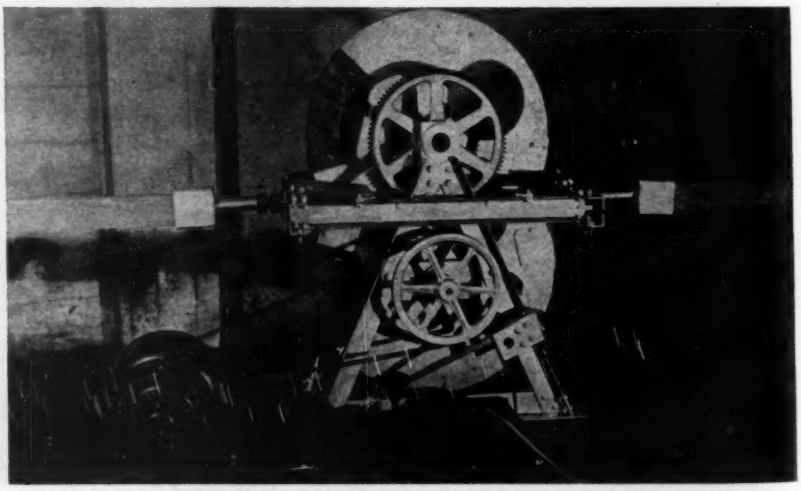


FIG. 1—THE BUILDING VIBRATOR has three rotating disks, two below and one above, to which lead plates are bolted. Speeds range up to 600 r.p.m.

of the building and resonance is set up between the machine and the building. This resonance effect shows up on the record by an increase in amplitude of the vibration.

Large effects of resonance noted

Fig. 3, which shows resonance curves, using various amounts of unbalance, indicates that for this particular building the natural period remains practically constant for all four amounts of unbalance used on the vibrator, and also that the amplitude of vibration is approximately proportional to the amount of unbalance. In run 1 an unbalance of 104 in.-lb. was used, and it was possible to speed the machine to nearly its maximum safe speed of 600 r.p.m. In runs 2, 3 and 4, unbalances of 576, 384, and 192 in.-lb. were used. In run 2, where the largest unbalance was used, it was not advisable or necessary to develop a higher speed than 370 r.p.m.

Fig. 4 shows a typical record obtained with the vibrator in a thirteen-story office building. In this test sixteen lead plates were used, and the speed of the machine was brought up to 400 r.p.m. (period equal to 0.15 sec.). At this speed the disturbing force acting on the building was 3,500 lb. The first part of the curve, up to the arrow indicating this speed, is a record obtained when the machine was being speeded up and is similar to the record obtained after the driving belt was thrown off and the machine started to slow down. At this point the long waves indicate the fundamental period of the building set up by wind, and the very small superimposed waves indicate vibrations set up by the machine.

As the machine slows down, the period increases, and at certain periods the amplitude of vibration becomes much greater than at other periods. This increase in amplitude is caused by resonance of the machine with the building. The first definite resonance point on the record is reached when the period is 0.23 sec. At this point the disturbing force had decreased to 1,470 lb., but the amplitude of vibration for this particular period increased almost enough to mask the fundamental period of the building. When the machine revolved at a period of 1.20 sec., it was in resonance with the fundamental period of the building, and a very large amplitude was recorded. Since the disturbing force at this speed was only 54 lb., the result illustrates how a small disturbing force can set up large vibrations when the period of the force is in resonance with the fundamental period of the building.

Dams and bridges investigated

To date, observations have been made on the Searsville Dam at Stanford University, Morris Dam in San Gabriel Canyon (both concrete structures), a four-story reinforced-concrete warehouse in Palo Alto, the Los Angeles City Hall, Colorado St. Bridge in Pasadena, a thirteen-story office building in San Jose, the ground at the New Mint site in San Francisco, and the ground at Mare Island. Mr. Blume has been in charge of the sub-party carrying on this fieldwork and has prepared reports on the records obtained.

The work on the Searsville Dam was the first attempt to vibrate a relatively low and rigid structure. Although the vibrator was speeded up to about 750 r.p.m., it did not pass through the fundamental period of the dam, which the shape of the resonance curve indicated was slightly shorter than 0.08 sec.

The Los Angeles City Hall observations, the first undertaken in a tall building, were made as much for the psychological effect as for the scientific value of the observations; building owners had been rather reluctant about permitting the vibrating machine to be used until it was shown that it would not damage the building. In the City Hall resonance periods were measured for some of the higher modes of vibration of the building. The vibrator was set on the 25th floor, and forced vibrations were well recorded down to the fifth floor, the lowest on which records were taken.

The observations on the Colorado St. Bridge showed that, because of the many component parts of the bridge, resonance could be secured at many different periods. The vibrating machine was kept in one position in the test, and the vibration meter was set at various places along the bridge. The typical resonance curve was irregular and complex.

The thirteen-story office building (Bank of America Building in San Jose) is the only building in which a comprehensive series of experiments with the vibrator has been undertaken. Simultaneous recording on different floors was successfully carried out. From the records obtained, it was possible to plot the deflection curves for the fundamental and the second mode of vibration, and to determine the approx-

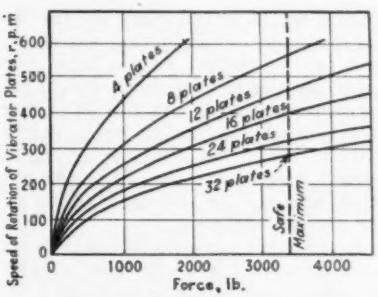


FIG. 2—FORCE CURVES for different plate loadings. Each plate adds 48 in.-lb. of unbalanced moment.

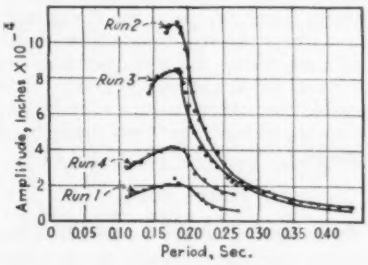


FIG. 3 — AMPLITUDE-PERIOD curves plotted from the vibration records of the Palo Alto Transfer & Storage Building, a four-story reinforced-concrete warehouse with hollow-tile partitions.

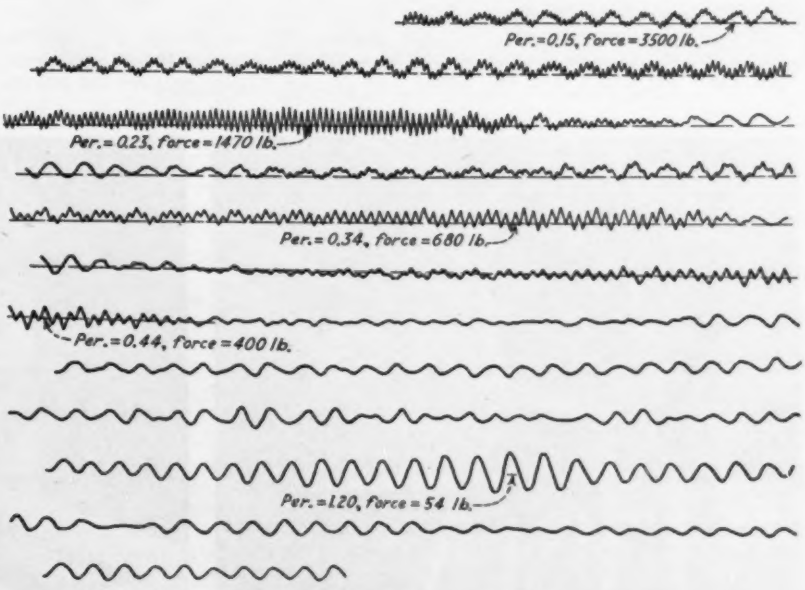


FIG. 4—TYPICAL VIBRATION RECORDS from a thirteen-story office building recorded as the machine slowed down and thus passed through the natural periods of the building and other characteristic zones.

imate centers of rotation for two torsional modes. Experiments of this type are necessary to provide definite and accurate data for any intelligent study of stresses set up during vibrations of a building. Without these experiments any study of vibrations would have to be made on the basis of theoretical assumptions. The experimental data also make possible a better analysis of damage caused by earthquakes.

Vibrations from explosion and traffic

To determine the possibilities of the vibrator for ground work, tests were made at the site of the new Mint in San Francisco, at the request of the procurement division of the Treasury Department. If possible, the dominant ground period was to be measured. Although vibrations were set up, there was no resonance response between the highest speed of the vibrator (580 r.p.m.) and the slower speeds. If there were any dominant ground periods at this site longer than 0.1 sec., they were not detected.

Observations were made with the ground set in forced vibration (*a*) by the vibrator, (*b*) by an explosion, and (*c*) by traffic. In the latter two cases, periods ranging from 0.05 to 0.1 sec. were detected. As this Mint site is a rocky hill extending up to nearly 100 ft. above the street level, these periods may be the periods of the hill itself, and not the dominant period of the surrounding ground.

In the Mare Island tests, observations were made on low dredge-filled ground in which the watertable is about 1 ft. below the ground surface. In all, 23 tests were made, and ground vibrations were measured as far as 1,000 ft. from the vibrator. Resonance curves plotted for each test show that there was no definite resonance point for the ground. On a few of the resonance curves, small peaks are shown, but these peaks do not all show up at the same period. It is possible that these peaks are caused by reflected waves from the underlying bedrock.

Future work

In general, it might be said that the present machine appears to be very suitable for intensive studies of buildings, and it is planned to carry on such observations in a few selected buildings, where special dynamic studies have been made or would be desired. For ground work, not enough tests have been made to determine its usefulness. It is hoped that the present vibrator will furnish sufficient information as to the advisability of constructing a larger machine.

It seems fitting that mention be made and credit given here for previous similar research. For a number of years, the Lösenhausen Works at Düsseldorf have been constructing commercially machines of various size for vibration work.

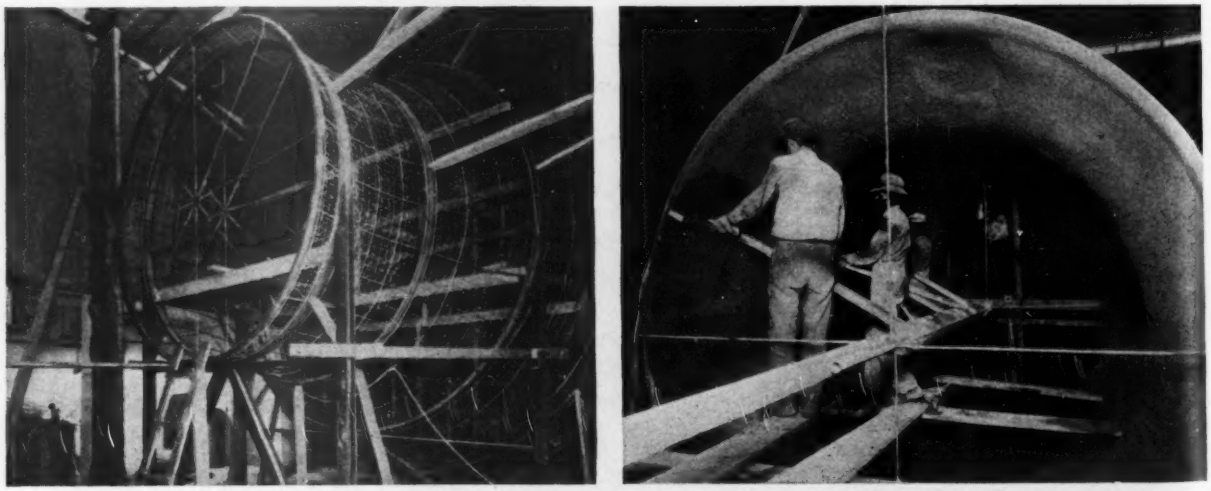
These machines have been used primarily to test bridges, and some work has been done with small dwellings and ground tests. The vibrating machine has also been used, very successfully, for compacting filled ground. Dr. Richard Köhler and others have carried on some vibration work in Germany, but it is believed that the U. S. Coast and Geodetic Survey tests constitute the first attempts to study the action of tall buildings and dams under forced vibrations.

Glue-Treated Mesh Serves as Backing for Air-Applied Concrete

By J. H. Lucas
Associate Professor of Civil Engineering, Georgia School of Technology, Atlanta, Ga.

IN THE CONSTRUCTION of the wind tunnel in the aerodynamics laboratory at the Georgia School of Technology the use of gunite applied on fine screening coated with water-soluble glue, to reduce the loss of mortar, is believed to constitute a unique operation. The tunnel is of the "open-jet closed-return" type developed by Ludwig Prandtl of the University of Goettingen, Germany. It is 156 ft. long on the axis, has a 9-ft.-diameter jet, and a 10-ft. gap or working space, which permits tests with models up to 6 ft. in maximum dimension. The interior diameter increases uniformly from 9 ft. at the gap to 19 ft. 9 in. immediately behind the 9-ft. jet. A 300-hp. synchronous motor equipped with an oversize exciter provides the power. This unit has a four-blade propeller hub, but only two blades have been installed. Wind velocities up to 100 m.p.h. are produced with the two blades, while 125-m.p.h. velocities are expected when the four blades are installed. For velocities below 60 m.p.h. the oversize exciter is used as a direct-current motor.

The balance on which air forces are measured operates on a new principle developed in the Georgia School of Technology. Forces are transmitted hydraulically and are balanced and indicated pneumatically. In operation the tunnel has been found to have several advantages over other types. The shell used is rigid enough to be prac-



WIND-TUNNEL CONSTRUCTION views showing (left) framework at nozzle end before glue-treated mesh was applied and (right) the completed interior surface being brought to true shape by a carefully centered templet.

tically free from the usual vibration, or "drumming," and air leakage is completely eliminated. These features materially reduce turbulence in the working jet.

Three types of construction were considered, and careful cost estimates on each were prepared. The estimates on steel-plate, all-wood construction, and the combination gunite shell with steel frame were respectively $14,000, $18,000 and $9,000. The last figure does not include the guide vanes.

The tunnel had to be designed to fit into the first story of the existing Aeronautics Building. Column spacing had to be met, and footings had to be increased in size in several places where it was not possible to locate new footings. The tunnel construction consists of steel ring frames and supporting columns, for the most part fabricated in place, to which reinforcing bars and mesh are fastened. The ring frames, spaced 3 ft. 2 in. to 7 ft. 8 in. on centers, are in general of welded channel sections, rolled flanges inside; at the ends of the tunnel and where the change in diameter is so abrupt that a channel ring would project either inside or outside the shell, 2-in. pipe is used. The longitudinal steel is plain ½-in. round bars passing through drilled holes in the channels or pipe rings. Hoops of ⅜-in. round deformed bars are wired to the longitudinal bars. In the top quarter of the frame two layers of ring reinforcement are used, one inside and one outside the longitudinal steel. All reinforcing bars are welded. To this framework of bars a 3x4-in., 12-gage galvanized wire mesh and a fine 8-wire screening was fastened, the screening being coated with a water-soluble glue. The glue reduced the openings in the screen about 50 per cent, and against this the inside lining coat was applied with small loss of mortar. After the inside was coated, the glue was washed off and the outside lining coat was applied.

The reinforcing steel, screening and gunite lent themselves very well to the warped surfaces at the corners where there is a transition from circular to elliptical section. This shaping is usually difficult with other materials. A chicle base, heavy-duty floor paint was used on the inside, and a very satisfactory dustless finish was secured.

The precautions taken to maintain true sections and alignment are shown in the photographs. The inner flanges of the channel rings were used as guides for screening the inside surface. These channel and pipe frames were held in shape by guying with piano wire and turnbuckles. In the vicinity of the jet, where special precision was required, a taut wire was set for an axis. Around this a pipe was adjusted with the wire at its exact center. The pipe was then used as a shaft about which a templet was revolved, to wipe the inside surface to true line and dimension.

The photographs also show the vanes used at the corners to change the direction of the air stream. These and other vanes located immediately behind the motor support assist in removing the twist in the air current induced by the propeller.

The power unit was mounted in a heavy steel sleeve supported by three sets of hollow steel tubes, which in turn are welded to the 12-in. channel and also bolted to the concrete wall. The steel sleeve is fitted with four sets of adjusting screws, which permits accurate centering of the motor and propeller. The 12-in. channel was rolled with the flanges out, welded and set in a solid concrete wall flush with the inside of the tunnel. This steel frame circle, with a diameter of 15 ft. 5⅛ in., forms the ring in which the propeller turns. A very rigid mounting has resulted. The propeller turns with approximately ¾-in. clearance only from the tunnel surface.

Engineers and contractors

Montgomery Knight, of the Daniel Guggenheim School of Aeronautics, developed the aerodynamic features of the design. The writer prepared the structural plans, and T. E. Moodie supervised construction. Rust Engineering Co., Birmingham, was the general contractor, with T. B. Hudson the superintendent in charge. Steel fabricating and direction were by Bird-Potts Welding Co., Atlanta, Ga.

Suspension Bridge of Timber Built by CCC Labor

SUSPENSION BRIDGE of 240-ft. span built by CCC men in Idaho.

AN INTERESTING EXAMPLE of CCC construction work is shown in the accompanying photograph of a light suspension bridge recently completed in Idaho. This structure, called the "Crevasse Bridge," spans the Salmon River 21 miles above Riggins at a point when the stream runs through a gorge 60 ft. deep. Climatically, the region is one of extremes, the temperatures encountered ranging from —4 deg. F. in March to 110 deg. F. in late May. The topography of the surrounding country is rough, and the area is sparsely settled. The nearest railroad station is at McCall, 64 miles away, and it was found expedient to transport all construction materials from McCall to the site by means of a 60-hp. crawler tractor drawing two 40-ft. bobsleds over snow 10 ft. deep in many places. Food and camp supplies were brought in by pack train from Riggins.

The span of the bridge is 240 ft., and it is 327 ft. long between anchorages. It is supported by eight 1½-in. diameter cables, and has a capacity of 16 tons. The wood guard-rails act as stiffening trusses. A "bulldozer" with grading blade removed was used to hoist into place the timbers that were too heavy for the winches.

The bridge was designed by J. P. Martin, regional engineer, U. S. Forest Service, Ogden, Utah, with E. Myers, forest engineer, McCall, Idaho, collaborating. It was built by CCC Co. 1996, now stationed at Cambridge, Idaho, with Capt. Chester W. Cohagen, F. A. Res., in command. Generous credit should be given to Wm. Ax, bridge foreman, for the success of the project.

Wire-Bound Rock Training Walls Solve Zion Park Flood Problem

Torrential Virgin River freshets being held in a defined channel and eroding valley bottom built up by use of walls of loose stone hooped and bound by steel netting

By Thomas C. Parker and Frank A. Kittredge

Assistant Superintendent-Engineer, Zion National Park

Chief Engineer, National Park Service
San Francisco, Calif.

FIG. 1—NET-ENCLOSED DIKE of loose stone repaired after heavy flood by opening the net and adding more stone. Net remained intact after settling, and structure is probably now below cutting action of river.

BASKET DIKES constructed along the Virgin River in Zion National Park, Utah, each year since 1928, have proved their ability to withstand the floods and provide ample bank protection for this torrential stream. Incidentally, as appears in the illustrations, these structures show a nice aptitude in producing shapely forms of loose stone by binding them with steel netting. This work involves only skilled direction of common labor and can therefore be carried on in remote park territory with a minimum of equipment and imported materials and consequently at reasonably low cost. Although the construction is used in other parks, the conditions and procedure in Zion Park only are described here.

Park and river conditions

Seven years ago the Park Service was confronted with the urgent need of protecting the floor of Zion Valley, lying between the precipitous walls of Zion Canyon from the rapid devastation and removal which was taking place from floods in the Virgin River. Zion Valley is about 7 miles long by ¼ mile wide. The park development, consisting of lodge center, public camp ground, roads, trails and sewer and water systems valued at $1,500,000, is all on the east side of the river. The general objective was then to confine the stream to the west cliffs by a series of revetments, straightening the channel, introducing long sweeping curves where necessary and thereby encouraging a fast runoff in a confined clear channel.

The Virgin River is a typical southwest mountain stream, subject to frequent floods, with the water rising 8 to 12 ft. in an hour. Although there then were the same storms, the flood conditions did not exist when the Mormon pioneers first settled the valleys in and below Zion National Park in 1853. Results of overgrazing by livestock on the watershed of the river were noticeable as early as 1870 when floods were beginning to occur. Due to the geological formation, the surface erosion was very rapid once the vegetation was grazed out. Gullies soon formed, and large areas were completely denuded at an accelerated rate. The silt and debris were carried down the countless small tributaries and into the main stream.

This river rushes through a narrow gorge for about 20 miles, and the load of silt is carried along until the upper end of the valley is reached. Here the sand-laden floods cut deeply and broadly into the narrow alluvial valley of Zion Canyon.

Obstructions such as sand bars are formed where debris is lodged against large boulders, and the stream's course is consequently changed time after time, and new soil erosion and destruction of land surface and vegetation take place. This valley is very important from a scenic standpoint as well as being the only area in the park suitable for the accommodation of visitors. Roads, trails and buildings were repeatedly menaced by these floods and changes in the channel.

Choice of structure

Previous to 1929, wing dams had been constructed at critical points by filling log cribs with river boulders enclosed in light wire mesh. This construction did not withstand the floods for many seasons, due to the logs rotting, the wire being too light, the boulders too small to stand the force of the water, and undermining, which broke these rigid structures. Something had to be done quickly.

There were several alternatives: first, reconstructing the rock-filled crib protection; second, the construction of rigid revetments; and third, the construction of a flexible type of revetment.

The fact that only sandstone is available in the valley, and that it cannot be economically quarried in great masses for so large a project pointed toward the so-called basket type of construction. The encasing of the entire revetment in six-gage, heavy, electrically welded wire mesh seemed to be the most practical means of obtaining the necessary flexibility and yet resistance en masse to the floods. Therefore basket dikes or revetments were designed, and construction was started in 1928.

The structure normally consists (Fig. 2) of a main dike or training wall along the bank. This is a trapezoidal wall of laid-up loose stone enveloped in steel mesh. Along the lower or stream side of the dike a cylindrical toe revetment of much smaller dimensions is placed. This is constructed in sections 10 to 20 ft. long and 3 to 4 ft. in diameter. As undercutting takes place, the toe revetment rolls into the trench. This undermining continues until the toe basket reaches a point of stability below stream cutting. This prevents undermining of the larger basket, as the toe basket forms a cutoff wall. This method makes submarine excavation unnecessary, lets nature do the work and is very effective and inexpensive.

While the greater portion of bank protection in Zion National Park is of the parallel type, several wing dams are in use. The cross-section of these wing dams is usually identical to that used in the parallel dikes, the only difference being that of position with respect to the stream current.

To date, no cross-stream dams have been constructed. However, study of the action of the river on the basket-dike construction for several years shows that there is a possibility of this being most practical for the control of depth cutting. Damming of the stream for the purpose of raising the water table of certain areas is desirable for the support of vegetation. Retarding of the flow will result in silting the channel back to its more nearly natural level.

There have been places where great undermining has taken place and the baskets have become distorted by fitting into the eroded channels. They still, however, are functioning perfectly, no matter how they roll. If additional height is necessary on account of the settlement, the baskets may be opened and additional rock added.

Restoration by silting

Great areas on the valley floor have been devastated by ever-changing courses of flood currents in past years, carrying uprooted trees, boulders and loam with them. These devastated channel areas behind the baskets in Zion have been barren gravel and sand wastes but are now being restored to a more normal condition by silting and natural seeding.

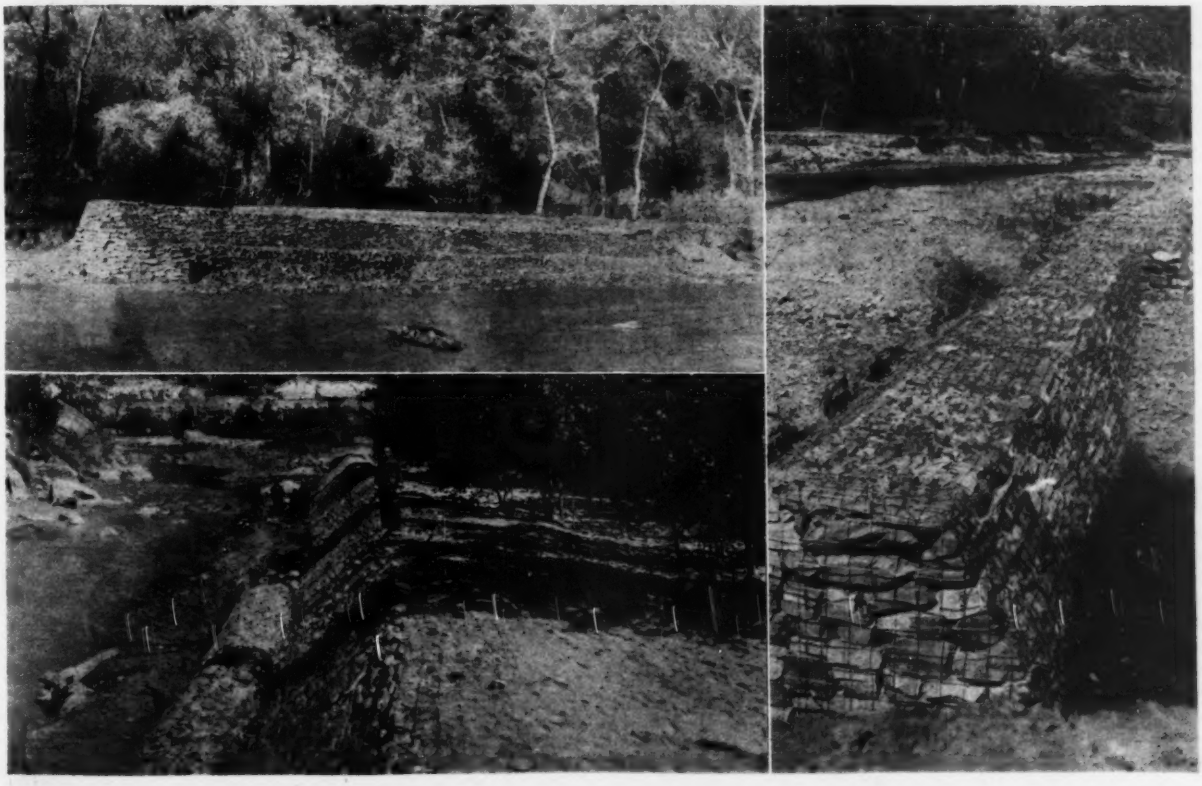
The object then of this river-control work is twofold: first, to confine the course of the cutting stream to prevent further devastation of the very precious vegetation and bottom land in the narrow valley; and second, to reclaim and restore valuable areas devastated by past floods.

The baskets, while high enough and sufficiently continuous to control the current, permit spilling of the silt-laden floodwaters over and around the dikes into the low places. A slight retardation of current is all that is required for the silt to settle and deposit. One large area near the Lodge was filled more than 3 ft. in one season and is now covered with willows and cottonwoods. All of the low areas are being filled, little by little, after each heavy flood, by this method. It will result in time in restoring most of the land on the east side of the river to vegetation.

The basket dams, both parallel and wing, have definitely been designed in location to provide for and encourage the floodwaters to spread out over the wide areas outside the controlled channel. The current remains within the prescribed channel, but slower-moving water is outside, dropping its

FIG. 3—DIKE AFTER A FLOOD, showing how silt deposition from overflow is gradually building up the land behind the dike.

FIG. 2—DIKE CONSTRUCTION is a remarkably neat operation carried on by common labor and simple tools. The toe basket settles to take up undercutting.



load of sand and silt and passing back into the main channel farther down the valley.

The cost of basket dams and revetments averages $3.80 per cubic yard, subdivided as follows:

Excavation and backfill	$ .50
Quarrying operations, including power, drilling, blasting, and loading rock	.75
Hauling, including drivers' wages and all truck operations (average haul, 8 miles)	.55
Placing rock in dam by hand	.65
6-gage mesh wire, including cutting, lacing, placing, and tying strips after rock is placed	1.25

The river-protection work of Zion Park was started under associate engineer Guy D. Edwards and continued for the last five years by engineer and assistant superintendent Thomas C. Parker. It has been carried on under the successive superintendencies of E. T. Scoyen, Tom Allen and P. P. Patraw, the present superintendent. A. B. Cammerer is director of the National Park Service and is under Secretary of the Interior Harold L. Ickes.

Advanced Clamshell Design Stresses Reduced Weight

A review of recent improvements in bucket shape and structure that have increased working efficiency

By Philip T. Robin
Engineer, Bucket Division, The Wellman Engineering Co., Cleveland, Ohio

COMPETITION in industry arising out of the economic conditions of the past few years has compelled the rejuvenation of many machines and processes that formerly had been regarded as quite satisfactory. The clamshell bucket has not escaped the general tendency toward reduced weight, refinement of line and inclusion of modern metals in vital parts—with the result that buckets of larger cubic capacity may replace older equipment without increasing the total load on the crane in many classes of work.

It is the purpose of this article to describe, briefly, these developments and to present specific data covering a wide variety of work—ranging from the handling of solid rock, to oyster shells and sugar beets.

Design improvements

In recent design practice, streamlining, or scientific forming of the shells to lessen resistance of materials entering the bucket, reduces the cable pull required to close the bucket and thus leave a greater part of the dead weight resting on the material. Centers of gravity have been lowered by cutting down unnecessary bucket height and also by hollow box construction in the upper parts of the bucket so that it is more stable when lowered onto the work. Higher closing ratios and longer cutting strokes have further contributed to efficiency, and designers have devoted much attention to matters of form and finished appearance, which harmonize with the improved quality of the parts beneath painted surfaces.

In a mechanism such as the clamshell bucket, which is frequently subjected to extraordinary strains and abuse, lighter construction quickly presents the problem of maintaining the necessary strength. This problem has been solved, first, by the liberal use of flanges, ribs and box sections, which are easily fabricated today by modern welding; and, second, by drastic reduction of shaft diameters and plate thickness, accomplished without impairment of either bending resistance or wearing qualities through the employment of proper alloy steels. Shell plates ⅜ in. thick but of 60,000 lb. per sq.in. yield strength, for instance, are fully equivalent to regular commercial steel plates ½ in. thick, and the saving in weight amounts to 25 per cent.

Heat treatment of high-carbon, alloy-steel shafts for maximum bending resistance also produces excellent bearing surfaces to withstand the high unit pressures and abrasive conditions of clamshell operation. Bushings suitable for these hardened shafts include the high-grade bronzes and alloy cast iron, the latter heat-treated to about 500 Brinell hardness.

Computing weight and load

For those who may be contemplating new clamshell equipment, or who desire to apply an efficiency test for existing plant, the following theoretical method for obtaining the weights of both bucket and load is suggested:

Begin with an assumption for rated size of the bucket to be used.

Refer to Table I, locate the class of material you wish to handle, and find the proper type of bucket opposite it in the next column.

Then consult Table II for the basic weight of the size you are considering, and multiply this weight by the weight factor headed "empty bucket," which corresponds with the proper type in Table I.

For example, suppose you are considering a 4-cu.yd. bucket for digging sand under water. Table I shows that the dredger type is recommended. Table II gives the basic weight for 4-yd. buckets as 12,500 lb., which is then multiplied by the factor 1.24, indicating

TABLE I—FACTORS FOR EMPTY BUCKET WEIGHTS AND FOR THE QUANTITY OF MATERIAL THAT MAY BE ANTICIPATED PER GRAB

Pounds per Cu.Ft.	Class of Material	Type of Bucket	Weight Factors	
			Empty Bucket	Net Material
65	Acid phosphate, lime, salt, plaster and granulated slag	General	1.00	.42
33	Ashes and cinders	Rehandler	.63	.35
85	Cement clinker	Clean-up	.70	.86
90	Clay (hard)	Dredger, teeth	1.32	.50
	Clay (hard)	Heavy dredger, teeth	1.75	.60
110	Clay (plastic)	General, teeth	1.08	1.03
	Clay (plastic)	Dredger, teeth	1.32	1.06
50	Coal (fine)	Light rehandler	.50	.50
50	Coal (run-of-mine)	Clean-up	.70	.44
	Coal (run-of-mine)	Light 4-rope	.75	.42
33	Coke (small)	Light rehandler	.50	.34
30	Coke (medium)	General or 4-rope	1.00	.32
	Coke (medium)	Clean-up	.70	.30
95	Earth excavation	General, teeth	1.08	.66
	Earth excavation	Dredger, teeth	1.32	.70
93	Gravel (¾-in. average)	Clean-up	.70	.75
90	Limestone (6 to 10 in.)	Light ore	1.14	.53
75	Muck (under water)	Clean-up	.70	.84
110	Mud	General	1.00	1.35
	Mud	Heavy dredger, teeth	1.75	1.40
100	Nitrates	General or 4-rope	1.00	.75
150	Ore (iron)	Ore	1.38	1.19
165	Ore (manganese)	Heavy ore	1.78	.87
55	Oyster shells (reef)	General	1.00	.43
60	Phosphate rock (3 in.)	General	1.00	.36
165	Pyrites (¼ in)	General	1.00	1.56
100	Sand (rehandled)	Clean-up	.70	.98
	Sand (rehandled)	General	1.00	1.65
105	Sand (under water)	Dredger	1.24	.82
35	Snow	Extra light rehandler	.42	.32
90	Stone (1½ in. crushed)	Clean-up	.70	.73
	Stone (1½ in., crushed)	General	1.00	.67
85	Stone (4 to 6 in.)	Medium dredger, teeth	1.60	.37
75	Stone ("one-man")	Heavy dredger, teeth	1.75	.16
160	Stone (large blocks)	Medium dredger, teeth	1.60	2.40
90	Sulphur	General or 4-rope	1.00	.72
40	Sugar beets	Light general	.75	.43

that the empty bucket for this class of work should weigh 15,500 lb.

Next, it is necessary to calculate the maximum quantity of sand that the bucket will be able to pick up in one grab. Consult Table I for the weight factor for net material—in this case, 0.82. Apply this factor to the 4-yd. basic weight of 12,500 lb., which gives the weight of material as 10,250 lb. But because the larger buckets are more efficient for their weight than the smaller sizes, it is necessary to qualify this result slightly by the application of an efficiency factor, which depends upon the size and is found in Table II. Multiplying 10,250 lb. by the efficiency factor 1.13 shows the actual load of dredged sand that may be expected to be 11,500 lb. The following data are now established:

	Lb.
Weight of empty bucket	15,500
Weight of sand	11,500
Total load on crane	27,000

Should this load be either greater or less than the easy lifting capacity of the crane, the ideal size for the bucket may be readily determined (within a reasonably restricted range) by means of direct proportion on the basis of the 4-yd. size and the 27,000-lb. load.

Type and capacity

The following is an interesting illustration of the possibility for increasing output of an installation, even one equipped with a modern bucket, by making a change to the most suitable type for the particular work involved. The unloading crane in a sand-storage yard carries a bucket of the general type, of 3¼-yd. capacity rating:

	Lb.
Weight of empty bucket	10,400
Load of sand, 10,400x1.05x1.11	12,150
Gross load	22,550

Assume a bucket of the cleanup type of 4-yd. rating. The increase in material handled is 1,650 lb. with no additional weight on the crane, as follows:

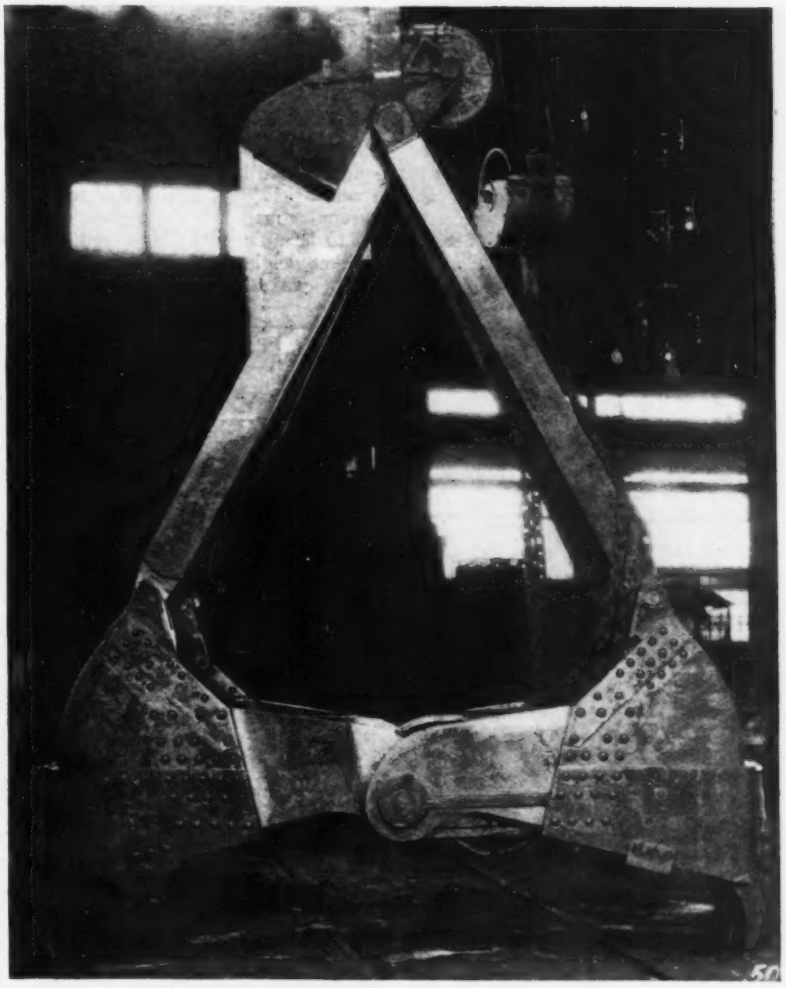
	Lb.
Weight of empty bucket, 12,500x.70 =	8,750
Load of sand, 12,500x.98x1.13	13,800
Gross load	22,550

After all, the operating department of any business whose problems include the handling of materials in clamshell buckets, is fundamentally interested in the output per hour; and it is into such terms that bucket capacity must finally be interpreted. As a criterion of normal performance the output of an installation should be: tons per hour $\frac{W'}{t}$, where W' represents the maximum net weight of material in pounds per grab and t the minimum number of seconds taken to make one complete cycle with the bucket. The formula includes allowances for the element of lost time in average operation, such as cleaning-up and moving of cars or barges, etc. It may be increased 25 per cent for best conditions; or reduced 20 per cent or more when unusual delays or shutdowns are encountered.

TABLE II—BASIC WEIGHTS, EFFICIENCY FACTORS AND SCOOP CAPACITIES OF CLAMSHELLS

Rating, Cu.Yd.	Basic Weight, Lb.	Efficiency Factor	Scoop, Cu.Ft.
¼	1,100	.87	7.5
⅜	1,600	.92	11
½	2,000	.94	15
⅝	2,400	.96	18
¾	2,900	.98	22
1	3,700	1.00	29
1¼	4,500	1.02	36
1½	5,300	1.04	43
1¾	6,100	1.06	50
2	6,800	1.07	57
2¼	7,600	1.08	64
2½	8,300	1.09	71
2¾	9,000	1.09	78
3	9,700	1.10	85
3¼	10,400	1.11	92
3½	11,200	1.11	98
3¾	11,800	1.12	105
4	12,500	1.13	112
4½	13,800	1.13	125
5	15,200	1.14	139
5½	16,500	1.15	152
6	17,800	1.16	166
6½	19,000	1.16	179
7	20,400	1.17	193
7½	21,700	1.17	206
8	22,900	1.18	219
9	25,400	1.19	245
10	28,000	1.20	272
11	30,400	1.21	299
12	32,800	1.22	326
13	35,200	1.23	353
14	37,500	1.23	380
15	39,800	1.24	407
16	42,100	1.25	434
17	44,500	1.25	460
18	46,800	1.26	486
19	49,000	1.26	513
20	51,500	1.27	540

The figures in the above tabulation are all based on definite formulas to insure uniformity. Buckets for general-purpose work, properly built at these basic weights, will prove adequate for the class of service intended.



CLAMSHELL BUCKET typical of recent design and construction.

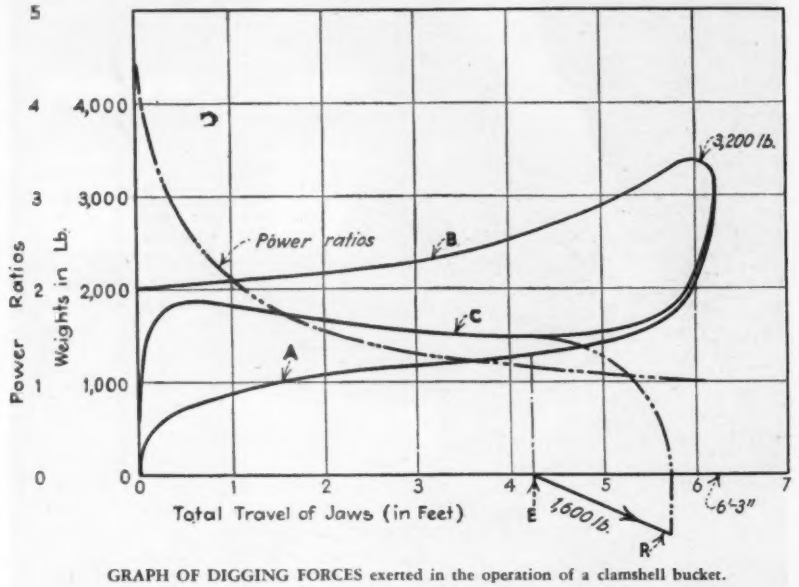
Analysis of digging action

The actual mechanics involved in moving the shells of a bucket through material from the open to the closed position have always been pretty much a mystery. Recently, however, experiments have been undertaken with the object of getting an analytical picture of the arrangement of forces attending the typical digging action. The accompanying graph indicates the results of this study. The example used is a dredger-type bucket of ¾-yd. rating, weighing 2,000 lb. empty and working in hard-packed sand under water.

The horizontal scale of the graph represents total travel of the cutting edges, or jaws, from zero at their wide-

open position to 6¼ ft., at which point the jaws come together and the bucket is ready to be hoisted free of the bottom. There are two vertical scales, one at 1,000 lb. per inch, for the curves A, B and C; the other, in units per inch, for the curve of power ratios. The latter is for the internal leverage by means of which a unit pull on the closing cable at the head of the bucket is converted into a force acting horizontally between the cutting edges of the jaws.

Curve A records the load on the closing cable going upward to the crane, starting at nothing and ending at 3,200 lb., the combined weight of bucket and load as it leaves the bottom. Curve B traces the combined downward weight of bucket and material, which gradually builds up as the shells fill. The hump in the curve, seen as the jaws are about to close, is caused by suction of the wet material. At any given point in the stroke a figure taken from the power-ratio curve and multiplied by closing cable pull, A, at the same station, will show the horizontal force developed between the jaws. This latter is represented by the curve C.



GRAPH OF DIGGING FORCES exerted in the operation of a clamshell bucket.

An investigation of the situation at station E, where the jaws still have about 2 ft. to go to complete the cutting stroke, shows the following condition, which holds true for the greater portion of the stroke in average materials:

The difference between curves B and A is 1,300 lb., half of which, or 650 lb., is the net downward pressure on the cutting edge of each shell. At the same station, curve C shows the horizontal pressure between the jaws to be 1,500 lb. So the resultant force R, which is the actual pressure exerted by each of the jaws against the material at the cutting line, will be approximately 1,600 lb., acting at an angle of about 24 deg. downward from the horizontal. This does not mean that the path of the shells will follow a 24-deg. slope, because resistance to penetration by the solid bed of material beneath the jaws is more than that of the loosened material passing above, so that the actual path is usually between 10 and 15 deg., and in hard materials will be much less.

This emphasizes the importance of providing sufficient bucket weight when digging hard compacted material from natural bed. While in the case of light granular materials the highest efficiency is to be attained by a reduction of the bucket weight, the opposite is true where hard excavating is concerned. Maximum output will then be secured by using the heaviest bucket recommended for the work in accordance with Table I on p. 686.

Comparison of dimensions

Whenever an attempt is made to compare or check up on general dimensions of clamshells, much confusion appears. This is because no standards have been universally adopted by the various manufacturers of this class of equipment. However, certain fundamental principles may be applied to the problem, which will greatly simplify it.

Suppose, for instance, that the name plate and purchase records of a bucket are missing and it is required to find the rated size. This may usually be accomplished by determining only two measurements, one the inside width of the shells and the other (the depth at the cutting edge) measured from the top edge of the side plate proper down to the cutting edge along the bottom of the shell, or scoop. Should it be difficult to determine the location of the top of the side plate, an alternative measurement is the extreme length inside the shells when the bucket is in closed position.

Average American practice establishes the depth at the cutting edge of a 1-yd. general-purpose bucket at 29 in., the extreme length inside at 60 to 65 in. and the width inside 38 in.; for this size a factor F is designated.

The formula, capacity in cu.ft. $= \frac{F^2 \times \text{width inside}}{1.31}$, is approximately true for all cases. F is obtained by dividing the actual depth at the cutting edge by 29, so that if a bucket is found to measure 55 in. in width inside and to have a scoop depth of 41 in., its scoop capacity will be $\frac{1.42^2 \times 55}{1.31}$ or 85 cu.ft., which, referring to the last column in Table II, identifies it as of 3-yd. rated capacity. $\left(\text{The factor } 1.42 \text{ is } \frac{41}{29}\right)$. All clamshell widths vary approximately as the cube root of the rated capacity, and various types establish widths in definite relation to the general types, as follows:

Rehandlers	10 to 15 per cent wider
Clean-ups	20 to 25 per cent wider
Dredgers same as generals	
Trench diggers	10 to 15 per cent narrower

Wire-rope problems

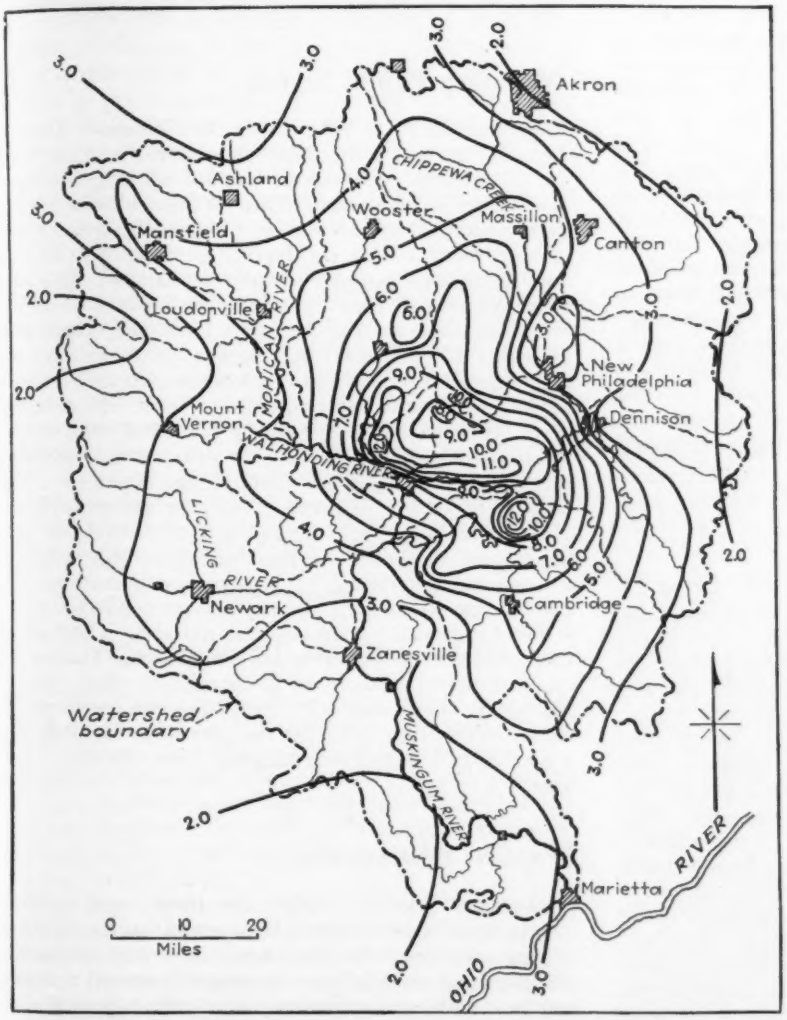
Because of the relatively small-sheave diameters and highly abrasive conditions of most clamshell operation, it is practically impossible to recommend a wire rope that will prove entirely suitable in all cases. Therefore this paragraph will be confined to a description of current practice in the field. Main sheave pitch diameters of 20 times the rope size are commonly employed, with a minimum of 16 and a maximum of 30 for non-fleeting installations. Fleeting buckets must have a pitch diameter of 30 to 40 rope diameters for proper operation. Maximum loads of 16,000 to 18,000 lb. $\times$ dia.^{2} seem to result in reasonably good performance when improved plough-steel rope is used, although failure will almost invariably occur in the bucket portion of the rope at relatively short intervals, depending upon the severity of abrasion.

In dredging practice, where buckets are frequently subjected to overload conditions, ropes sometimes are loaded as high as 2500 lb. $\times$ dia.^{2} but breakages then occur too often to suit the average user. This latter condition is usually caused by the necessity for handling heavy loads occasionally, coupled with limitations such as score of the hoist drums, or sheave diameters, which render it impossible to use large rope.

The most durable rope for clamshell work is considered to be the style B flattened strand of 6x25 construction, with wire-rope center and, of course, improved plough-steel wire. In more common use will be found the 6x19 or 6x37 construction, the latter being used only on grooved hoist drums. When the chain is reeved directly into the bucket, minimum-pitch diameters should be held to 20 times the chain size to minimize wear between the chain links.

Rainfall in Muskingum Valley Unusually Heavy in August Storm

Previous abnormal precipitation on watershed reduced available ground storage and caused intense runoff in final storm which rapidly brought streams to maximum stages



ISOHYETAL LINES on the Muskingum Valley watershed show the concentration of unusually heavy rainfall in the center of the region, which exceeded in many places the previous official 24-hour maximum for Ohio.

ADDITIONAL DATA on the unusual storms in south-central Ohio on Aug. 6 and 7, which caused the worst floods since 1913 and halted work in most sections of the Muskingum Conservancy District, have been compiled by T. T. Knappen, senior engineer in the U. S. Engineer office at Zanesville, who prepared the accompanying isohyetal map which is based on the rainfall records of the Weather Bureau stations and supplemented by numerous unofficial observations in the affected area.

The 8.7 in. of rain recorded by the Weather Bureau at Newcomerstown exceeded the previous official maximum in Ohio of 7.4 in. in 24 hours, but this figure falls considerably short of what actually fell on neighboring areas. Precipitation of 8 in. or more, with an unknown maximum in excess of 12 in., occurred over an area of about 500 square miles.

Previous maximum stages were exceeded in practically all streams having watersheds of less than 300 square miles in the area of heavy precipitation. The largest stream on which the 1913 peak rates were exceeded was Killbuck Creek, which has a drainage area of 613 square miles. In the five weeks preceding Aug. 6 several summer storms passed over the Muskingum River watershed, three of which were characterized by unusually heavy rainfall in various localities. Two storms, occurring in the period Aug. 1 to 3, inclusive, delivered about 2.9 in. of rain over the whole region and materially reduced the ground storage, which otherwise would have been available to reduce runoff from the final storm. During July the rainfall was about 2.25 in. above normal.

During the Aug. 6-7 storm, the average precipitation over the 8,038-square mile watershed was 4.09 in. Above McConnellsville, where the drainage area is 7,410 square miles, the average precipitation was 4.25 in., 53 per cent of which ran off. Runoffs in excess of 15 to 20 per cent very rarely occur on this watershed as a result of August storms. On Sugar Creek at Strasburg (drainage area 310 square miles) a total runoff of 6.25 in. from the watershed occurred. As the isohyetal map indicates only 6.5 in. of rainfall, it is apparent that there were exceedingly heavy rainfall centers on the area which were not found by the investigations. The impression following the field examination is that several such instances occurred, and that the map errs by falling short of, rather than overstating the rainfall.

The rainfall, beginning at 6 p.m. on Aug. 6, was of about 14 hours' duration, and the resulting flood waves were characterized by very rapid rise and long-continued high stages. At Coshocton it produced the third highest, and at Zainesville the fourth highest stage of record. This is the only recorded instance in which the main stem of the Muskingum River has risen over its banks in the summer season. Coming at harvest time, the agricultural loss has been very severe, and in this respect this flood is in sharp contrast to previous damaging floods of spring occurrence. Incomplete figures indicate a total direct loss of between $5,500,000 and $6,600,000.

Honorary Members, A.S.C.E.

In the list of men elected to honorary membership in the American Society of Civil Engineers, published in our issue of Oct. 24, p. 580, the name Mortimer E. Conley was included. This was an error; the name should be Mortimer E. Cooley.

The other men elected to honorary membership were John W. Alvord, John F. Coleman and William J. Wilgus.

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November 14, 1935

Surveys Turned Down

AFTER the PWA had announced that $901,164 had been allotted to the Coast and Geodetic Survey to complete the working up of data collected at a cost of about $10,000,000, it was discovered that the President had failed to indicate that he had approved the allotment by putting his initials beside this particular item on the list of projects submitted to him. For lack of the President's initials an eminently useful piece of work is eliminated from the works program, and 600 engineers, draftsmen and others are deprived of useful jobs at a time when the government is supposed to be making every effort to create useful work. We cannot believe that the President, with his knowledge of the importance of adequate maps, deliberately failed to initial this particular item, especially as the field data now in the hands of the Coast and Geodetic Survey are useless until compiled and published. But if his action was deliberate, it must be charged to the fact that the item was not adequately explained to him. In either case, there is no reason why his approval should not again be sought.

Good Work!

THE ICY BLASTS of a Montana winter have forced the four dredges at Fort Peck Dam into winter quarters, closing a construction season in which all dredging and dirt-moving records were surpassed. Overcoming the handicaps of a new organization, untried equipment and the delays consequential to getting a huge project started, those in charge at Fort Peck in one short season piled up the greatest volume of earth ever accumulated by man in so short a space of time. Some 22,000,000 cu.yd. of fill was placed in six months, and though Fort Peck is yet less than 25 per cent complete the fill now exceeds that of Gatun Dam, long the world's largest earth structure. A dredging plant designed for an output of 3,000,000 cu.yd. per month has turned more than 3½ million yards monthly for the last three months. Such performance is the result of good equipment and good management. The designers and manufacturers provided the four rugged dredge units that together pumped an average of 4,700 cu.yd. per hour for over five months of steady work. Army engineers and their civilian associates provided the management necessary to obtain the high output from the equipment. Credit is due the Fort Peck group for notable achievement.

Engineers Are Recognized

AMERICAN ENGINEERS may well join with their fellows in Canada in finding satisfaction in the appointment of an engineer, Clarence D. Howe, to an important position in the cabinet of the new dominion premier King, and in the naming of three engineers to make up the new electricity commission of the province of Quebec. Mr. Howe was born and educated in this country; thus in taking on his new position he joins that notable group of Americans who have distinguished themselves in service to Canada. In his new position Mr. Howe will head up a department to be created by consolidation of two departments which now direct the major government engineering operations. Supplementing this significant recognition of the public importance of engineering work, the Quebec electricity commission appointments place further emphasis on the same fact. In a province where lawyers heretofore have held almost undisputed control, these appointments suggest that political leaders are acquiring a practical understanding of the peculiar fitness of engineers to administer affairs in which engineering plays a large part.

Necessary Public Service

ESTABLISHMENT of a bureau in the Commerce Department for the study of construction statistics is an innovation of major importance. Heretofore the government has recognized the significance of agriculture, of domestic and foreign commerce, of manufacture, by systematic study of current reports of their activities as well as through periodic census compilations. But construction, though near the top in the register of industries, received no such study. Even the importance of census data remained unrecognized until recently; the 1929 census was the first to include construction records, though it did so in sadly incomplete form. Now that a new and probably more complete census of construction is being undertaken, we have in prospect a foundation for continuous study of construction activities. The value of this study, of course, lies in the intimate relation of construction to the employment of both labor and capital and to general business activity. Not only the volume and distribution of construction operations, but also the conditions under which they are conducted exert a direct influence on the national welfare. The factors that promote the stability of construction cannot be weighed in the absence of a continuous check on the industry's operations. If then, the new government study succeeds in bringing the economic facts of the construction industry into tangible form, the result will benefit all.

Prophets Confounded

LESS THAN FIFTEEN YEARS AGO there were eminent members of the profession who asserted that the obituary of long-span bridge-building should be written forthwith. All necessary major stream crossings, it seemed to them, had been built, and engineers must henceforth look elsewhere for a field in which to exercise their talents. How wrong they were is now patently apparent. From 1925 to 1930 more big bridges were built than in any like period. The depression not only failed to check this trend but helped to accelerate it. Hard times indeed brought a vision of the inadequacy of our bridge equipment. As a result, the need for five large bridges along the northern part of the Coast Highway is now being met, as described in this issue. The bridges at San Francisco over the Bay and the Golden Gate appeared out of dreams grown old and all but forgotten. The Mississippi River crossings at New Orleans and at Davenport, the Missouri River bridge at South Omaha, the Rip Van Winkle Bridge over the Hudson, to mention some of the other recent undertakings, also are not

the products of made-work schemes; they have real economic basis. The prophets who are now confounded by the turn of affairs were probably led astray by the assumption that additional large bridges could not be afforded. Actually the base on which rests the economic justification for new bridges has been so constantly enlarged by highway traffic growth that the building of large bridges seems assured for many years to come.

Express Highways

THE REVIEW of Italian highway development presented in this issue brings out significant phases not commonly understood by those who have witnessed it from the distance of America. Directed at first to superhighways, Italian roadbuilding policy has changed to the logical purpose of providing roads for more common use. This does not mean that the high-speed express road is being abandoned—in fact it is being steadily advanced—but that it will be constructed as a logical arterial system of a nationwide network of main roads. Italy and Germany contrast with America in that here the express highway is only beginning to be considered. The wide boulevards that we have built in metropolitan areas, while comparable in every structural quality with the express highways of Italy and Germany, are not, as these are, intrastate and interstate trunklines for fast and heavy through traffic. This is the next advance necessary to place state and national roads in America in the category of truly developed systems for motor-vehicle transportation. The highway engineer has this problem facing him, and he has few determined facts to guide in its solution. A task of deep and farsighted thinking is before the highway engineer in planning the future automobile and truck express roads of the United States.

To Safeguard Bridge Piers

ORDINARILY the design of a bridge pier takes account not only of superstructure loads but of all loads that may be brought to bear against the pier above ground line, while below the ground line there is assumed to be complete balance of active forces. Since common experience shows this to be a logical and satisfactory procedure, any exceptions that occur are worthy of most careful study.

When one of the piers of the Vicksburg bridge across the Mississippi River tilted slightly some years ago, it was found that a subaqueous slip or slump of the sloping channel side was responsible. That case gave warning of what may occur under unusual soil conditions when a pier is founded in earth. No reason appeared for believing that a pier on rock foundation is subject to a similar risk. Now, however, the peculiar accident to the right main pier of the Grand Coulee highway bridge over the Columbia River proves that even in case of rock foundation the pressure of a landslip may do damage.

The facts so far reported (*ENR*, Nov. 7, 1935, p. 646) are not sufficient to define the extent or character of the slip, but do indicate that a heavy pressure against the land face of the embedded pier base was developed—enough to tilt it out of its shallow socket in the firm granite that forms the floor of the ancient river gorge, 75 feet down. The gorge-filling, much of it a fine-grained, silt-like or clay-like soil that is known to become unstable when disturbed and wet, evidently moved in a large body when slight benching on the bank near the bridge disturbed its equilibrium and started landslip cracks in the foreshore.

The large forces evidenced by this action should be remembered by pier designers. Where the subsoil is such as to make slips or slumps even a remote possibility, it will be wise to provide extra stability and ample reinforcement to resist any tendency to bend or break the pier. But for fuller guidance it is to be hoped that the facts of the Grand Coulee slip will be more completely explored than has yet been possible.

Structural Dynamics and Earthquakes

IT IS only a few years since defense against earthquake destruction advanced from a state of raw empiricism to a rank of a science. The transformation came about through recognition of the separate importance of earthquake action and structural resistance. From that time on, continuous advance was made, and we now have reason to look forward to seeing earthquake protection becoming a practical art.

First of the two main items of progress was the evolution of earthquake-force measurement to the advanced stage embodied in the "strong-motion" seismometer investigations of the Coast and Geodetic Survey that are now in progress. In this work the quake motions are measured near their point of origin, which is where structural damage is localized. The other element, perhaps even more important, is progress in the analysis of structures to determine how they resist shaking forces. This work was motivated especially by fear of disaster through destruction of schools and other buildings of public assembly. California, where this motive was most powerful, became the world's foremost laboratory for research in earthquake resistance.

At first only the static strength of structures was given consideration, but it soon appeared that their dynamic strength may be essentially different, as inertia, resonance and damping modify the static strength profoundly. At the same time it became evident that theoretical calculation is hardly adequate to determine dynamic strength, largely because the make-up of most building structures is too complex to be amenable to analytical formulation.

Out of this situation grew the plan to investigate structural dynamics through experiment, partly by tests of models on shaking tables, partly by measurement of the motions of full-sized structures under the impulse of artificially imposed oscillations. In many respects the work on full-sized structures has the most immediate practical bearing. Its progress to date, as briefly reviewed in the present issue, indicates that advance expectations of its value are being fully realized.

It is already certain that the study, if energetically continued, will bring forth information fundamental to the attainment of security against earthquakes. When this information is in definite shape, it will then be the task of engineers, architects and public officials to put it to practical use. While we need never look for complete security against the most violent disturbances of which the earth's crust is capable, such application should bring assurance of protection comparable to our protection against flood, wind and wave.

CURRENT NEWS

New Quebec Commission Made up of Three Engineers

Three engineers have been named by the provincial government of Quebec to make up the recently authorized Quebec Electricity Commission. They are A. Frigon, chairman, O. O. Lefebvre and J. W. McCammon. Salaries of chairman and members, respectively, are to be $15,000 and $10,000. A. Frigon is a well know Canadian electrical engineer, director of technical education for the province of Quebec, and principal of the Polytechnic School, Montreal. O. O. Lefebvre is a widely known civil engineer, a past president of the Engineering Institute of Canada, and chief engineer of the Quebec Streams Commission since its formation in 1913. J. W. McCammon is also a civil engineer, a graduate of McGill University, and for several years associated with the Beauharnois Power Corp.

The new commission was created by the provincial legislative at its past session as the outcome of a legislative commission report. Its powers are wide, and are independent of governmental interference, since the commissioners can be dismissed only by the Lieutenant Governor of the province, on a joint address of the Legislative Council and the Legislative Assembly of the province. The commissioners will be eligible for pensions on the same basis as provincial judges.

The commission has power generally to hold enquiries into all matters pertaining to the supply of electricity in the province. It will be the judge in cases of dispute between a power company and a municipality; and it may order any public utility to extend its lines or network system in the public interest. Its approval must be given to all construction work carried out by power companies. No public service may suspend any of its operations without its approval. All schedules of power rates must be filed with the commission, and no increase will be permitted without showing justification to the commission. It may set rates upon its own motion, as well as upon complaint. It may approve or disapprove of the terms of contracts hitherto existing, and all capitalizations of public services are under the supervision of the commission which will require uniform bookkeeping.

Fort Peck Dredging Operations Shut Down for Winter Season

Sub-zero weather at Fort Peck dam forced the four dredging units into winter harbor on Oct. 31, bringing to a close the first season of filling operations during which 21,750,000 cu. yd. of material was pumped into the dam embankment. The first season's dredging operations were started late in April, but did not get fully under way until the first of June. Since the latter date an average of 4,700 cu. yd. per hr. was placed in the dam. During August, September and October the monthly total exceeded 3,500,000 cu. yd.

PWA Power Loan Test Delayed By Action Of Lower Court

SUPREME COURT consideration of a test case from some 30 pending actions challenging the government's right to finance competitive municipal power systems through PWA loans and grants was delayed, perhaps beyond the limitations of the present session, by the District of Columbia Court of Appeals, which on Nov. 8, sent the most advanced case back to the District of Columbia Supreme Court.

The case involved is Oklahoma Utilities Co. v. Harold L. Ickes, et al., involving a PWA loan and grant of $150,000 to the town of Hominy, Okla. The action was initiated in the District of Columbia Supreme Court, which ruled in favor of the government. The case was then taken to the Court of Appeals, which heard arguments on Oct. 7 and was expected to rule shortly. Meanwhile, however, the form of PWA contract between the government and borrowing municipalities had been modified. An attempt to introduce the revised contract form into the case was ruled out. Now, on application of the government, the case has been remanded to the original court for arguments on the new contract form.

PWA attorneys deny that this action will necessarily delay a test in the U. S. Supreme Court, stating that there is a distinct possibility that the Court of Appeals may be skipped and the case carried directly to the highest court. Meanwhile, it is possible that other pending cases may be speeded up to provide a substitute for the Hominy action.

New suits have been brought in the district Supreme Court as follows: Glenwood and Janesville, Minn., by the Northern States Power Co.; Delta, Colo., by the Western Colorado Power Co. Both involve PWA loans for the construction of competitive municipal power systems.

In Kirksville, Mo., a special election to approve a $352,000 bond issue to match a PWA allotment of $288,000 for a municipal power and light plant was defeated.

District court restrains PWA

The District of Columbia Supreme Court has issued a restraining order against a $472,000 loan and grant by PWA to the city of Grand Forks, N. D., for a municipal electric plant. The Northern States Power Co., complainant, claims that an investment of $950,000 is jeopardized and that construction of a municipal plant would prevent it from serving nine surrounding communities.

With the thought in mind that court tests of PWA aid for the construction of municipal power plants are purposely being delayed until after the Dec. 15 deadline for awarding contracts, PWA Administrator Ickes has announced that no allotments for municipal power plant construction will be rescinded. This action was also approved by WPA Administrator Hopkins.

New York to Investigate Rail Rates on Road Materials

A complete study of railroad freight rates charged on highway construction materials has been ordered by the New York State Public Service Commission and the first hearing has been scheduled for Dec. 16.

The action was prompted by a recommendation by the Division of Highways that carload rates on road building materials be standardized and made as nearly uniform as possible. The recommendation is not interpreted as a complaint involving unfair charges or discrimination, but it is pointed out that no state-wide study or comparison of rates on these materials has ever been made by the commission. It is believed that rate standardization would be of great assistance to state engineers in preparing estimates of costs on highway projects and to contractors in preparing bids. It is also believed that the railroads would benefit in many instances as a result of standardization of rates as it would give them an opportunity to compete with truck haul between many points where rates are too high and the rate structure too inflexible to permit of proper adjustments promptly. The rigid rate structure maintained by the carriers has given rise to numerous requests for emergency rates. Many of these have been granted while many others have been refused by the carriers.

Truck haul rates can be readily secured by engineers and contractors on the basis of price per ton mile of haul, whereas rail rates may not be estimated on such basis. When the state as a whole is considered a wide disparity in rail rates is found in many instances, hence engineers often find such bulk commodities as gravel or stone taking a rail rate of 60c. a ton for a 50 mile haul on one project while on another project in an adjoining county a rate of 90c. a ton for a 30 mile haul might obtain.

The study just ordered is to cover intrastate carload shipments only and will embrace such construction items as, stone, sand, gravel, slag, ore-tailings, steel, cement, asphalt and bituminous products.

Geo. H. Flinn Corp. Second Low On New York Subway Bid

The George H. Flinn Corp., New York City, with a bid of $5,590,787, was second low bidder for the construction of the first section of the Sixth Ave. subway. This figure was on an alternate calling for the use of excavated rock for improving Rikers Island. On the alternate allowing the contractor to dispose of the rock, the George H. Flinn Corp. submitted a bid of $5,294,287, while the Rosoff-Brader Construction Corp., to whom the contract was awarded, submitted bids of $5,583,768 and $5,452,768 on the two alternatives, respectively. Last week's issue of *Engineering News-Record* listed the George H. Flinn Corp., New York City, as George A Flynn Co., Pittsburgh, Pa.

Los Angeles To Build Five Débris Basins in Denuded Area

Appropriations of $85,000 for the immediate construction of five emergency débris basins above Altadena, Calif., to prevent possible flood damage to Altadena and Pasadena from rain run-off in the 2,500 acre mountain area burned over in a fire Oct. 23, have been voted by the Los Angeles County Board of Supervisors. Forces under the direction of C. H. Howell, chief engineer of the county flood control district, have begun work on the basins, which will serve as temporary guards against possible floods. Altadena is a residential community on the north boundary of Pasadena and at the base of the south slope of the Sierra Madre range. The fire of Oct. 23 followed a night of high wind and burned over an extensive area of brush cover and destroyed a large sanatorium and a number of homes and cabins. As an erosion control measure the acreage burned over is being planted under the direction of the U. S. Forest Service and the county forestry department.

The county flood control district has no immediate plans for flood control construction work in the Malibu mountain area where 35,000 acres were burned over in a fire which began Oct. 24. This area, sparsely inhabited, is north and west of Santa Monica, the hills paralleling the coast line for many miles in Los Angeles and Ventura counties. Consideration is being given to planting in this area also in order to prevent serious damage from heavy run-off in the burned over area.

Supervision of WPA Airports Given to Commerce Department

Technical supervision over the selection and prosecution of airport projects in the relief works program has been delegated to the Department of Commerce, which has divided the country into seven regions, subdivided into seventeen districts, each in charge of an experienced aeronautical technician. A list of 750 proposed projects which meet WPA standards has been turned over to the department for investigation and approval. The examination covers such features as suitability of location, conformity with the general plan for airport development, and technical features. Small projects of $50,000 and under can be approved directly by the district representative; those of $100,000 or less must go to regional headquarters for final approval. More expensive undertakings must be referred to Washington. When a project is approved it is added to the list of available jobs from which the state WPA director makes his selections for actual construction.

The department has already approved 250 of the 750 proposed projects and hopes to cover the entire list during the present relief program. Although some projects are being returned to their local sponsors for modification, none are being rejected. All airports on the list are for commercial aviation purposes, principally under municipal ownership. About two-thirds are new ports; the remainder are existing ports which are to be improved or extended. In all cases the owners must give reasonable assurance that proper maintenance will be provided during the life of the port.

PWA Will Not Interfere In Award of Contracts For Foreign Materials

(Washington Correspondence)

PWA will not interfere in the award of a contract for German steel piling by the Morehead City, N. C., Port Terminal Commission. PWA officials take the same neutral attitude with respect to the contract that Triborough Bridge Authority may award for German steel, although they profess that the matter has not been brought to their attention officially.

PWA holds that economic considerations involved in German competition are not within its province, that it is not a tariff fixing agency. It is obvious, however, that a severe strain will be put on PWA's complacent attitude if German manufacturers are able to deliver any large volume of steel at anything like the prices bid on piling for the Morehead pier.

On 1,350 tons for this project, Koechner Steel Co., 75 West St., New York City, bid $42.80 per ton, delivered on barges; $45.30 on cars, according to PWA. Bids by four domestic companies—Jones & Laughlin, Bethlehem, Carnegie and Inland, were as follows: On cars, not welded $55 a ton, welded in pairs $65, corner piling $70, keys $85.

The German steel does not need welding and, according to PWA, a fair comparison shows that the domestic price on steel welded in pairs, on cars, is 152 per cent of the German price of piling, delivered on barges. The lowest comparison shows that the domestic price for steel not welded, on cars, is 122 per cent of the German price, on cars.

PWA insists that it will stand by regulations, previously attacked by the steel industry, which permit contractors on PWA-financed projects to purchase foreign materials if lower in cost, after allowing a 15 per cent differential in favor of domestic materials on purchases where the foreign bid is $10,000 or more.

Since its last tiff with the Steel Institute PWA has modified an administrative order specifying that the foreign material must be purchased if the purchaser is the borrower of PWA funds (i.e., the city sponsoring the project), and may be purchased if the purchaser is the contractor. Purchase of foreign materials, under such circumstances, has since been allowed to be optional in both cases.

Contract required taking lowest bid

Nathan Burkan, Chairman of the Triborough Bridge Authority, is trying to pass the responsibility to PWA with reference to purchase of German steel, according to Administrator Ickes, who explained that PWA's contract with the Authority and the latter's contract with the general contractor required award to low bidder, in accordance with NRA regulations in effect at that time. Ickes claims, however, that the Triborough Bridge Authority could have protected its contract if it had wished to by requesting PWA to include in its loan and grant agreement a provision barring purchase of foreign materials.

A differential in favor of domestic materials applies to the Morehead City project, Ickes said, because the allotment was made from this year's appropriation and is subject to PWA's administrative order establishing such preference. He also said PWA has jurisdiction of the Morehead project because the purchase contract for steel was made directly by the borrower of its funds and not by a contractor.

Asked what action PWA might take if a large volume of German steel should come in for PWA projects, Ickes said it would be appropriate to "advise ourselves of all conditions, that if it is dumping, or if German manufacturers are subsidized, it is something to take into consideration." Asked if investigation is contemplated he said PWA would not be the agency to make it, insisting that if domestic companies have a complaint they should go to the tariff commission. Asked whether he thinks the price of domestic steel furnished to PWA projects is too high, Ickes said he had not gone into that but added that it is a strange coincidence that domestic bids on the Morehead contract were identical.

England Announces 5-year Plan Of Highway Extension

That the government of Great Britain would embark on a 5-year program for the extension and improvement of roads at a cost of about $500,000,000 was announced by the Chancellor of the Exchequer, Neville Chamberlain, in a talk on Nov. 8. In addition to the normal grants for road building, the government is to give special assistance for the improvement of main roads. Dual roadways and bicycle paths will be constructed and grade crossings and weak bridges will be eliminated. On the same day the government announced that it would soon offer loans for the financing of railway improvement plans up to about $125,000,000. Such action, which would enable the railways to modernize their locomotives and rolling stock as well as to improve stations and rights of way, is in line with the recent treasury guarantee of $200,000,000 extended to the London transport board for improvement of rapid transit facilities in London.

Atlanta Sewer Program To Be Joint PWA and WPA Project

Atlanta's $6,000,000 sewerage and drainage program, conceived as a PWA project and later taken over by WPA, will be divided between the two agencies. PWA has approved a grant of $616,718 to cover 45 per cent of the cost of three projects costing $1,370,486. WPA will contribute $3,964,540 and the city, according to Earle Cocke, state director of the National Emergency Council in Georgia, will put up the balance. The PWA projects embrace the South River drainage area, estimated to cost $403,026; Utoy Creek drainage area, to cost $182,460; and the Clayton (Peachtree and Proctor Creeks) project to cost $785,000 (*ENR*, Oct. 31, 1935, p. 624). No loan from PWA's revolving fund was requested by the city, which plans to sell in the investment market sufficient bonds to cover its share of the cost. It is expected that sewer construction will get under way shortly.

A.A.E. Directors Make Plans To Add to Society's Usefulness

Formulation of an eight-point policy platform to increase the usefulness of the American Association of Engineers was the principal action taken by the board of directors of the association at its annual meeting held in Chicago Nov. 4-6. The board also adopted a budget of $35,000, including an item for advertising, revamped the association's publicity program and decided on changes in the scope and format of *Professional Engineer*.

The policy platform covers specifications for positions and minimum salaries, a unified placement service, principles of good professional conduct for employer and employee, working toward uniform license laws, development of enforcement agencies, legal service, creation of a welfare foundation.

Report of the employment division indicated that large corporations are employing few men over 32, whereas prior to the agitation for federal old-age or retirement pension laws 40 years was the deadline. Placements of engineers by the employment service is brisk, averaging 2 per day at present. For the four depression years ending Oct. 1, 1935, the following numbers were placed in engineering positions, 60, 70, 100 and 242. Some 2,000 engineers were placed last year in non-technical jobs for which no charges were made. These engineers are slowly getting back into engineering work.

Fully paid membership numbers 4,100, partially paid number 1,800 and dues have been remitted to an additional 1,000. The association has 17 chapters ranging from Ohio to the West Coast. Founder clubs are being formed among the original founders in honor of the association's "coming of age" this year.

Favorable investment of the permanent fund has increased the principal of the fund to $12,000.

New directors installed included Prof. F. H. Felgar, University of Oklahoma and Carl E. Painter, Salt Lake City. Howard A. Levering, senior assistant engineer, State Road Commission of West Virginia, was elected president.

Quake-Resistant Construction Planned for Houses in Helena

A tentative committment has been made by the Federal Housing Administration to insure a mortgage not to exceed $200,000 for an earthquake-resistant low cost housing project in Helena, Mont., sponsored by the Helena Development Co., a private limited dividend corporation.

Plans call for construction of at least 50 detached or semi-detached dwellings. Barclay Craighead, state director of FHA, and Stewart McDonald, national administrator of FHA, have been in constant communication since the recent earthquakes and arrangements were rushed to completion in order that the project can be undertaken without delay.

Following the tremors which caused serious damage in Helena on Oct. 18, Sigvald L. Berg, chief architectural supervisor of FHA in Montana, collaborated with city engineers in formulating a new building code which includes clauses concerning quake-resistant construction.

American Water Works Sectional Meetings Attract Two Midwest Groups

WITH an attendance of 140 at Sheboygan on Nov. 5 and 6, at the Wisconsin Section meeting of the American Water Works Association and with approximately 200 registered at the Missouri Valley Section meeting in Des Moines, Nov. 6, 7, and 8, waterworks men in the Middle West displayed vigorous interest in exchanging ideas on plant operation and methods for improvement of service. In addition to discussions on purely local problems and activity, some of the sessions were devoted to cross-connection hazards and to seminars on PWA and WPA functioning in relation to waterworks construction.

Addressing the Wisconsin meeting, Herbert C. Schmitt, engineer of construction, described the construction plant layout of the $4,500,000 purification plant now being built in Lake Park, Milwaukee. Concrete for the 750,000-gal. wash-water tank and for the filter units is hauled from a central mixing plant located 7 miles away and distributed by pipe line from pumping plant on a boulevard above the land side of the filter-plant site. The pipe, through which the concrete pumped a maximum of 1,400 ft. under 750 lb. pressure at the rate of 80 ft. per minute, at times contained 14 batches of material which required 15 to 20 min. for delivery to distant points. The constant fear of "freezing" the line through any halt in the delivery of concrete made necessary unusual precautions to have forms and steel set so rigid as to resist movement.

The Two Rivers 2-m.g.d. purification plant described by E. J. Donnelly, city manager, was built especially to remove from Lake Michigan water tastes and odors due to vegetable decomposition. Chlorine, ammonia and activated carbon are used. The units comprise two 30-min. mixers, two 4-hr. settling basins which are cleaned every 6 mo., four 500,000-gal. filters and a 200,000-gal. washwater tank.

• J. C. Zufelt, superintendent of filtration at Sheboygan, led a round table discussion on filter plant operation devoted to taste-and-odor control and maintenance of sand beds. The former seemed amenable to ammonia-chlorine and carbon treatment, but aeration was considered of doubtful value. W. U. Gallaher, superintendent, water department, Appleton, said that the municipal aerator with colored lights playing on it at night created a good impression but removed but 10 per cent of the odor. Alum, ammonia, ahead of the long settling period, 8 to 24 hr., and heavy carbon dosage, ahead of filters, gave good results.

In Chicago, said Arthur E. Gorman, engineer of water purification, protection of the distribution system from cross-connections and dual systems is being sought by requiring such consumers to provide receiving reservoirs with the city water pipes absolutely disconnected. Chicago has suffered five outbreaks of typhoid and dysentry in two years, all attributed to cross connections. H. E. Jordan, chemist, Indianapolis Water Co., reported an outbreak of 30 cases of typhoid from this cause.

Missouri Valley meeting

C. M. Stanley, consulting engineer, Muscatine, Ia., opened the meeting of the Missouri Valley Section by presenting a convincing economic argument for water softening. Although there is growing interest toward softening in this region of hard water supplies its successful promotion depends on a showing that can be made by savings to the consumer in soap used, harm to fabrics, heat losses in heaters and boilers and extra expense in operating them. While an evaluation was given to each item the soap loss was shown to be the largest item for consideration. With a reduction of 200 p.p.m. he showed that the soap saving alone is essentially sufficient to balance the cost of operating and financing a softening plant.

A paper on small impounding reservoirs referred entirely to hydrologic considerations in Iowa watersheds and was derived largely from studies and surveys made in this state on drainage areas of from 1 to 10 square miles. Since 1924 continuous rainfall and runoff observations have been made on a small watershed near Iowa City and the decade of records was used in the analysis of storage requirements for small reservoirs in the central territory. The paper was prepared jointly by E. L. Waterman, professor of sanitary engineering, University of Iowa; F. T. Mavis and Edward Soucek of the Iowa Institute of Hydraulic Research.

The 1933 amoebic dysentery outbreak in Chicago has led many health officials throughout the country to investigate faulty plumbing as a health hazard. The Missouri State Board of Health had such a survey made by twenty FERA engineers in St. Louis at a cost of $5,000. Plumbing was examined carefully in swimming pools, hotels, hospitals and dairies; these being selected as probably offering the greatest hazards. The 38 swimming pools had 187 defects, 4 hotels had 3,025 defects, the 4 hospitals 1,197 defects and the 6 milk establishments had 210 defects. Remedial measures from the physical standpoint, said Mr. Scott, are much less difficult than from the administrative standpoint.

Iron to the extent of 45 to 60 p.p.m. occurs in the shallow wells supplying Indianola, a suburb of Des Moines. J. J. Hinman in opening the discussion on the iron removal plant stated that he never saw so much ochre around a waterworks. For many years a silo type of structure with the water dropping through splash plates to a 500,000-gal. settling tank reduced the iron to 8 or 9 p.p.m., still high enough to stain fixtures and make bed sheets yellow. In 1933 Lafayette Higgins, the other author of the paper on the subject, built a plant including aeration, lime softening, recarbonization and filtration in which the iron is reduced practically to zero. Manganese is reduced from 1.4 p.p.m. to 0.1 p.p.m.

The newly elected officers of the section are as follows: Chairman, D. L. Erickston and vice-chairman N. T. Veatch, Jr. The secretary-treasurer is Earle L. Waterman, Iowa City. Some discussion took place looking to an extension of the programs to cover more operation and maintenance problems of a simple nature for the benefit of the small plant operator. Cloakroom talk indicated that conferences in the separate states sponsored jointly with the state health boards was probably the best way to handle this educational feature.

Three PWA Engineers Suspended As Result Of Contract Award

THREE PWA engineers in Rhode Island were suspended on Nov. 9 and informed by Administrator Ickes that written charges would be presented as soon as prepared, which they would be given a reasonable time to answer. The suspended officials are L. A. Hoffman, PWA state engineer for Connecticut and Rhode Island, Hartford; William Albrecht, Jr., and Frank B. Perry, PWA engineer examiners, Providence.

Suspension of these officials arose out of the award of a contract to the New England Machine & Electric Co. for lighting an airport at Warwick, R. I. The contract was not awarded to the low bidder, a mandatory requirement of PWA regulations, but bids other than the one on which contract was let, were declared to be unsatisfactory and the bidders were permitted to withdraw them, according to the report made to Administrator Ickes by investigators.

The award of the contract was approved by Hoffman, Perry and Albrecht and violation of PWA regulations was discovered in the routine review of contracts in Washington by the engineering division and investigation division of PWA. Jabez Gholston, director of engineering, refused to approve the award.

State would incur liability

State authorities representing the Rhode Island Emergency Public Works Corporation to which PWA made a grant of $124,000, representing 30 per cent of the cost of labor and materials of the $450,000 project June 21, 1934, were consulted by PWA and advised to breach the contract. It developed that the state would incur liability as the contractor had ordered materials and put a large amount of equipment on the job.

PWA is without authority to protect or indemnify the state but court action declaring that the contract was improperly awarded presumably would remove this obstacle, in the opinion of PWA officials. Suit to bring the matter to the courts has been instituted by another contractor.

Bids for New Jersey Approach To Midtown Tunnel Opened

Bids for the construction of the New Jersey land sections and plaza of the Midtown Hudson Tunnel from Weehawken, N. J., to 42d St., New York City, were opened by the Port of New York Authority on Nov. 7. Bids were received on alternates calling for the use of cast iron tunnel lining and approach work and for the use of structural steel. On the alternate calling for the use of cast iron George M. Brewster & Son, Bogota, N. J., submitted a bid of $4,360,588.50; Underpinning Foundation Co., New York, $4,511,453; Necaro Co., Inc. and Arthur A. Johnson Corp., Brooklyn (joint bid), $4,600,212. On the alternate calling for the use of structural steel the bids were $4,375,618.50; $4,493,373; $4,579,702, respectively. It is expected that contracts will be awarded soon so that work can be begun by Dec. 1.

OHIO ROAD SECTION EQUIPPED WITH NEW LIGHTING SYSTEM

The growing interest in adequate highway lighting in an effort to reduce the number of accidents has led to the installation of a new lighting system on 1¼ mi. of road on route No. 422, near Chagrin Falls, Ohio. A photo-electric cell switches the system on or off, depending on the natural light available.

A total of 39 units are used to light this section. Each unit is 25 ft. above the road and extends 5 ft. over the pavement. The units are spaced at 125-ft. intervals. Each light has a 400-candlepower incandescent lamp and an oval-shaped, terraced reflector.

Development of this type of lighting system is the result of studies made on scale models. An indoor highway model built to one-eighth scale, 250 ft. long and representing a 2,000-ft. section was set up in the Nela Park Laboratory of the General Electric Co. for use in working out adequate highway lighting.

Four More REA Projects Receive Approval

Four additional projects have been approved by the Rural Electrification Administration, which will loan the total cost of $1,065,528 for 915 mi. of distribution line to serve 4,039 families. All four loans are being made to cooperative organizations, one of which is state-wide in scope.

The largest of the contracts and the first to be made with a state electrification authority calls for 511 mi. of line in 22 South Carolina counties. The South Carolina Rural Electrification Authority, of which several state officials and four college presidents are members, will borrow $542,328 to bring electricity to 2,128 farms. Power will be purchased at an average wholesale rate of 1¼c. per kw.-hr. and resold at a base price of $4.65 for the first 100 kw.-hr. per month.

The Shelby County Rural Electric Cooperative will construct 270 mi. of rural line to serve 1,005 families at a cost of $350,000. The organization is sponsored by the Farm Bureau Rural Electrification Cooperative, Inc., a state-wide body which will supervise construction, maintenance, operation and management. Interconnection will be made with lines of a Miami County project recently approved by REA.

The Monroe County, Miss., Electric Power Association has borrowed $81,000 to build 55.3 mi. of rural line to serve 361 families, and the Meigs County, Tenn., Electric Membership Corporation will serve 545 farms with 78.6 mi. of line costing $92,200. Both will purchase power from TVA and resell at $3.50 for 100 kw.-hr.

New Construction Equipment Association Organized

Following a favorable response to letters from 84 manufacturers of construction equipment an organization meeting was held Nov. 1 in Chicago to form the Construction Equipment Association. Some 24 executives of manufacturers were at the Chicago meeting and 38 companies have already become charter members.

Purposes of the organization were adopted essentially as follows: To work for stabilization of merchandising methods; to promote the use of machinery as against costly hand labor methods; to utilize insignia to indicate standards of capacity; to work for state laws prohibiting unfair trade practices; to set up committees to counsel and advise with groups of manufacturers to bring about the adoption and arbitration of fair methods of competition; to represent the industry in negotiations regarding any codes of fair competition voluntary or otherwise that may be authorized by Congress; to act as a clearing house for lawful exchange of credit information; to gather and analyze statistics and to cooperate in improving the relations between manufacturers, distributors and consumers.

Officers elected to serve until the annual meeting to be held in Cleveland at the time of the American Road Builders' Association road show and congress, to be held during the week of Jan. 20, 1936, are as follows: President, S. F. Beatty; vice-presidents, O. G. Mandt and Morgan Butler; treasurer, C. L. Dunham; secretary, William Parrish; executive secretary, William Ogden, 410 N. Michigan Ave., Chicago, Ill.

New York WPA Head Asks Engineers for Sound Projects

Speaking before the fall meeting of the New York State Association of City and Village Engineers at Ithaca, N. Y., on Nov 8 Lester W. Herzog, state WPA administrator, requested the municipal engineers of the state to furnish WPA with good sound projects upon which to work. He stated that he wanted the projects to be properly planned, designed, conducted and inspected by the engineering sponsors. The WPA, stated Mr. Herzog, wants to do good and worthwhile work with a minimum of waste, though some waste is admittedly inevitable. Supervisory forces are being supplied by WPA, but the local engineers are expected to report to the district or state administrator any neglect or inefficiency on the part of the foremen and superintendents. All employees are expected to do a day's work, or they will be dismissed.

Mr. Herzog charged that the long delay in getting the relief works program under way was due to the delay in approval of projects by Comptroller General McCarl, and was not the fault of the WPA organization. New York state work was forced into starting earlier than other states because of the disastrous floods in late July, which called for immediate work. To date projects valued at more than $190,000,000 have been submitted to WPA, far exceeding the fund of $54,000,000 available for New York, exclusive of New York City. Notwithstanding the excess of projects, Mr. Herzog urged additional worthwhile projects to be filed, as many of the earlier projects have already been discarded as useless. Approval has just been received for numerous blanket projects, and new work can be included under the blanket provisions.

Many questions were asked by the audience concerning the status of projects estimated under the original labor regulations, now subject to revised wages and hours. Mr. Herzog stated definitely that all projects started would be finished. He looked to increased efficiency, economies in materials purchases and to other reductions in expenses to meet the increased costs occasioned by the changes in labor regulations, but also voiced the opinion that the blanket appropriations might be used to finish projects for which funds were allocated under the original conditions.

The contract system is not and will not be used on WPA work in the state, according to the speaker. He stated that many contractors were being engaged as superintendents, but not as contract managers. His remarks concerning contractors were far from complimentary, and he gave his audience the impression that WPA force account work was superior to that done by contract.

Following the talk a general discussion was held. Several engineers inquired about the advisability of assessing the cost of WPA work against local property. Only one city, Binghamton, has actually assessed and collected for relief works projects, in this case for a storm sewer. It was pointed out that there is no objection to assessments being made to recover the city's share of the cost of work, but that federal funds were donations, and their value could not be assessed.

The spring meeting of the association will be held in Corning late in April.

SOCIETY CALENDAR

HIGHWAY RESEARCH BOARD, annual meeting, Washington, D. C., December 5-6.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, annual convention, Miami, Fla., December 9-12.

WASHINGTON IRRIGATION INSTITUTE, annual meeting, Wenatchee, Wash., December 12-13.

AMERICAN SOCIETY OF PLANNING OFFICIALS, state planning conference, Chicago, Ill., December 12-13.

NATIONAL RIVERS & HARBORS CONGRESS, special meeting, New Orleans, La., December 13-14.

AMERICAN ENGINEERING COUNCIL, annual meeting, Washington, D. C., January 9-11, 1936.

AMERICAN ROAD BUILDERS' ASSOCIATION, annual convention and road show, Cleveland, Ohio, week of January 20, 1936.

CONSTRUCTION EQUIPMENT ASSOCIATION, first annual meeting, Cleveland, Ohio, week of Jan. 20, 1936.

NEW YORK STATE HIGHWAY CHAPTER, Associated General Contractors of America, tenth annual convention, Albany, N. Y., December 4-5.

EXPOSITION OF CHEMICAL INDUSTRIES, fifteenth annual exposition, New York City, December 2-7. Metals and alloys, plastics and plant equipment will be included among the exhibits.

EXAMINATIONS for registration of professional engineers will be held in the near future as follows:

IOWA—Examinations for registration by the Iowa State Board of Engineering Examiners will be held at the State House, Des Moines, Iowa, December 3-5, 1935.

Schenectady Plans Additions To Sewage Treatment Plant

Plans have recently been approved by the New York State Department of Health and an application for a PWA loan and grant has been made for major additions and remodelling of the Schenectady, N. Y., sewage treatment plant, estimated to cost $221,000.

The present plant, comprising nine Imhoff tanks and three acres of trickling filter beds, is inadequate to serve the entire population of 65,000 and can only treat 8½ m.g.d. of sewage. The balance of the flow, approximately 5 m.g.d., is being by-passed into the Mohawk River without any treatment. In order to provide sufficient capacity for present and future needs when an anticipated population of 100,000 is reached, Morris M. Cohn, sanitary engineer of the Schenectady department of public works, has prepared plans for increasing the plant capacity to 15 m.g.d.

The existing intercepting trunk sewer in the city will not be enlarged but its capacity will be increased to 30 m.g.d. by increasing the flow line gradient. This sewer, 6 ft. in width and 3½ ft. in depth, is laid at a grade which gives a present drop of only 1.63 ft. in its entire length of 8,300 feet.

Conversion of six Imhoff tanks into settling units with mechanical sludge collecting equipment will provide 1½ hours detention for the entire flow and the clarified and chlorinated effluent will be discharged into the Mohawk River. Two treated sludge digestion tanks, each 60 ft. in diameter and 24 ft. deep, will provide digestor capacity equivalent to 1.32 cu.ft. per capita, and in addition, three existing Imhoff tanks will be used for sludge storage tanks. The gases from digestion will be stored in a 10,000 cu.ft. gasholder for use in operating a 75 kw. engine-driven generator that will supply sufficient power for all plant uses.

Obituary

JOHN HOLT, assistant superintendent of streets at Cambridge, Mass., died on Oct. 28 at the age of 54.

JOHN J. FLYNN, for many years a contractor at Salem, Mass., died at his home in that city on Oct. 29 at the age of 82. He had retired some years ago.

ALBERT E. VICINUS, 57, former member of the firm of Whitmore, Rauber and Vicinus, road contractors, died at his home in Rochester, N. Y., Nov. 7.

CHARLES W. BRONSON, a civil engineer of Seattle, Wash., was killed on Oct. 23 when he, while completing a survey, was struck by an automobile. Mr. Bronson, who was employed by King County School District No. 51, was 63 years old at the time of his death.

GILBERT H. FIFIELD, who recently retired after 30 years' service as a civil engineer on the New York City board of water supply, died suddenly at his home in Provincetown, Mass., on Oct. 13. He was born in Cambridge, Mass., 60 years ago and had been connected with the Ashokan and Gilboa dam projects.

ARTHUR W. CLARK, who had been in charge of the construction of Conowingo Dam, Md., and of the Long Beach, Calif., plant of the Southern California Edison Co., died in Philadelphia on Nov. 8, at the age of 56. Mr. Clark at one time was vice-president of the Stone & Webster Corp., New York, and of General Refractories Co., Philadelphia.

THOMAS S. SHEPPERD, at one time president of Ulen & Co., Lebanon, Ind., died there on Nov. 8. Mr. Shepperd, who was 54 years old at the time of his death, had been engineer in charge of the construction work on the Shandaken tunnel carrying water for the city of New York, through the Catskill Mountains. Mr. Shepperd began his engineering career in 1900 as chainman and instrument man for the Denver Union Water Co. A year later he went as topographer and chief of party in preliminary location with the Alaskan Railway; at the close of this work he spent three years with O'Brien & Rhodes, Denver, Colo., making preliminary investigations and surveys for irrigation projects, waterworks and sewage designs. In 1905 he went to Mexico and spent five years there designing sewers, waterworks and railway systems, and in 1907 was appointed engineer for the state of Chihuahua. Following his return to Denver in 1910 he spent three years on various general engineering work and in 1913 went with the G. A. Gillespie Co., New York City; in the same year he was made vice-president of the company in charge of the Pittsburgh office. He later went with Ulen & Co. and in 1930, after having served as president, was elected chairman of the operating committee.

WALTER L. STEBBINGS, consulting engineer of Chicago, Ill., died in that city on Oct. 25. Mr. Stebbings had at one time been employed by the Edge Moor Iron Co., after which he became assistant engineer of the Drainage Commission for the city of Chicago and later went with the Keystone Bridge Co. He then became assistant engineer of bridges with the Chi-

cago and Northwestern R.R., and later gave up that position to begin his consulting engineering work, in which he specialized in bridges and buildings.

RUDOLPH WELCKER, an internationally known civil engineer in the fields of irrigation, tunneling and marine work, died at Springfield, Mass., on Nov. 8. He was born at The Hague, Holland, 55 years ago and was educated at the Institute of Technology in Delft. His foreign work included an irrigation study for the Persian government, and membership on the Nile Bridge Commission. He was superintendent of the Delta light railways at Cairo and was assistant engineer of public works at The Hague. He also did important work in connection with tunnel construction at New York City and served the U. S. Navy in 1917-19 in drydock and marine base work, besides making many inventions for pneumatic conveyors as well as in hydraulic engineering.

IRWIN SHELDON OSBORN, vice-president of the C. O. Bartlett & Snow Co., disposal equipment manufacturers, died in Cleveland, Ohio, on Nov. 2. Mr. Osborn, who was 56 at the time of his death, was known as an authority on municipal waste disposal. He graduated from both Oberlin College and Purdue University and for twenty years acted as consulting engineer for a number of cities in both the United States and Canada, specializing on waste collection and disposal problems. Mr. Osborn joined the C. O. Bartlett & Snow Co. in 1922 and subsequently became vice-president and director. During his connection with the concern he superintended the construction of waste disposal plants in cities such as Cleveland, Columbus, Montreal, New York, New Orleans and Birmingham. From 1917 to 1920 he was consultant for the city of New York on garbage and rubbish disposal and shortly after his work there went with the Bartlett Co.

CONSTRUCTION STATISTICS FOR THE WEEK

ENGINEERING construction awards total $28,773,000 for the 4-day week due to the Armistice Day closing and following the 4-day election-day week. Of this total, $6,479,000 is for private construction and $22,294,000 for public. Federal awards account for $4,597,000 of the public, and state and municipal for $17,697,000. A year ago corresponding totals were: total, $21,076,000; private, $3,746,000; public, $17,330,000; federal, $1,340,000 and state and municipal, $15,990,000.

Highway awards at $9,373,000 account for a good gain over last week as do waterworks awards at $3,703,000, industrial buildings at $2,275,000 and commercial buildings at $3,558,000. Earthwork, drainage, waterways is up to $3,605,000 after an exceptionally low figure last week. Public building awards this week at $2,909,000 are the lowest for 8 weeks.

The larger awards include: new chlorine manufacturing factory for Pittsburgh Plate Glass Co., Barberton, O., $1,250,000; Apartment house, E. 167th St., Grant and Morris Aves., New York, N. Y., $450,000; first unit of $850,000, 12-story apartment house for H. A. Clark, Miami Beach, Fla.; highway awards by Illinois, $960,000; Minnesota, $500,000; Oklahoma, $429,000; Arkansas, $403,000; Nebraska, $1,060,000; Missouri, $650,000; Texas, $1,799,000; bridges by Illinois, $513,000; 76,287 ft. precast concrete pipe for Colorado River Aqueduct, 2 contracts, Metropolitan Water District, Los Angeles, Calif., $3,097,000; Contracts 110, Div. E, Job 510, Contracts 112-A, Div. D, Job 410-A, Minneapolis-St. Paul Sanitary Sewer Dist., St. Paul, Minn., $657,000,000; and 8 contracts on Atlantic-Gulf Canal, Florida, $2,915,000.

New capital for the week includes state and municipal bond issues, $5,228,000, non-federal PWA allotment, $43,332,000. The total volume of new capital entered since the first of the year is $2,567,442,000 included 25 per cent of WPA allotments for construction, compared with $1,199,536,000 a year ago.

CONTRACTS
(Thousands of Dollars)

	Weekly Average Nov. 1934	Week Prev.4 Weeks	Week Nov.14 1935
Federal Government	$6,333	$5,598	$4,597
State and municipal	16,724	21,105	17,697
Total public	$23,057	$26,703	$22,294
Total private	3,826	8,790	6,479
Week's total	$26,883	$35,493	$28,773
Cumulative to date: 1934	$1,205,546,000	1935	$1,261,136,000

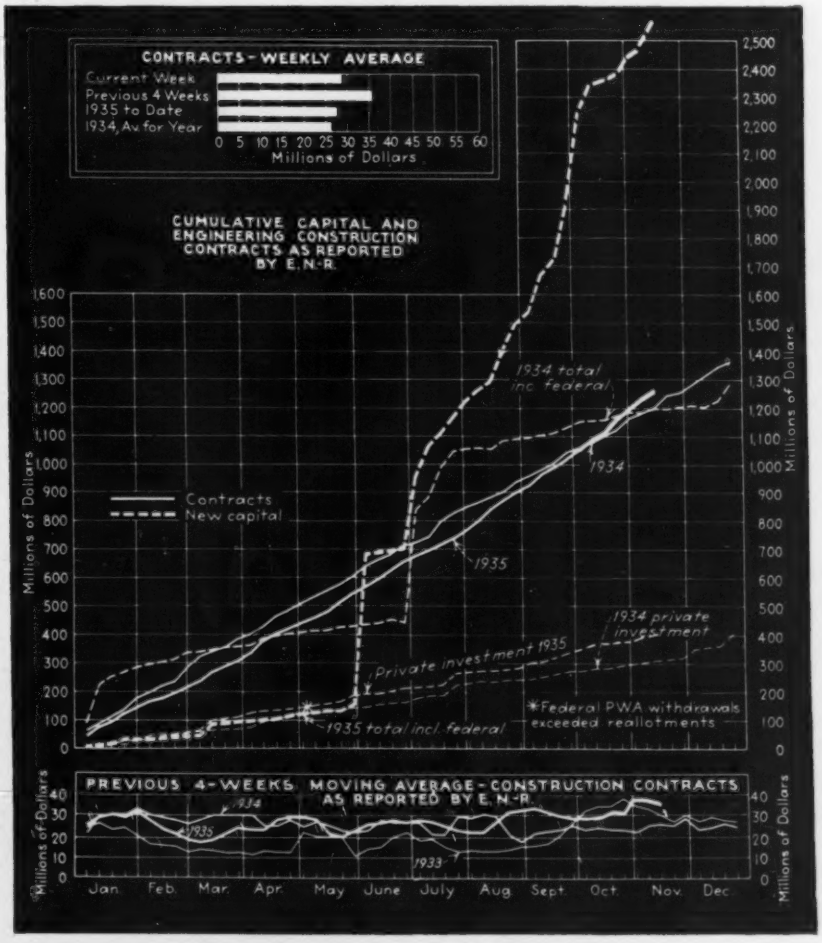
NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

1935	Week Nov.14	Cumulative
State and municipal	$5,228	$375,472
PWA allotments, S&M.	43,332	786,169
RFC loans, S&M	....	48,180
Corporate issues	....	27,738
PWA private	....	9,086
Local contrib. to WPA.	1,702	31,861
Total non-federal	$50,262	$1,278,506
PWA federal	50,901	1,288,936
Total new capital	$101,163	$2,567,442
Cumulative to date: 1934	$1,199,536,000	1935	$2,567,442,000

Note: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities, including the special highway funds; PWA private loans, and allotments for federal construction, deficiency act funds. An arbitrary percentage (25%) of the WPA allotments and local contributions to WPA work is included to allow for the capital additions through the Works Progress Administration division of the new program.

INDEX NUMBER

ENR Cost	1913 = 100	1926 = 100	ENR Volume	1913 = 100	1926 = 100
Nov., 1935	194.90	93.69	Oct., 1935	162	71
Oct., 1935	195.10	93.82	Sept., 1935	127	56
Nov., 1934	201.36	96.76	Oct., 1934	101	44
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50
1933 (Av.)	170.18	81.80	1933 (Av.)	102	47
1932 (Av.)	156.97	75.45	1932 (Av.)	127	56


CONTRACTS - WEEKLY AVERAGE
Current Week
Previous 4 Weeks
1935 to Date
1934 Av. for Year
0 5 10 15 20 25 30 35 40 45 50 55 60
Millions of Dollars
CUMULATIVE CAPITAL AND ENGINEERING CONSTRUCTION CONTRACTS AS REPORTED BY E.N-R.
Millions of Dollars
Contracts
New capital
1934 total incl federal
1934
1935
1934 private investment
Private investment 1935
1935 total incl. federal
*Federal PWA withdrawals exceeded reallotments
PREVIOUS 4-WEEKS MOVING AVERAGE - CONSTRUCTION CONTRACTS AS REPORTED BY E.N-R.
1934
1935
1933
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.

Current Construction Unit Prices

Bills Brook Dam, Hartford

COMPLETION of Bills Brook dam on the east branch of the Farmington River, 20 miles northwest of Hartford, Conn., is under way with the award in June 1935, by the Metropolitan District of Hartford County, of the upper portion of the project supplementing the stream control works and lower part of the dam just completed under previous contract. Construction includes the extension of the concrete corewall from a minimum height of 3 ft. to a maximum of 63 ft., with a bottom width of 10 ft., a top width of 4 ft. and a total length of 1,440 ft.; the raising of the rolled earth embankment 75 ft. with a finish top width of 164 ft. and length of 1,500 ft. from its present dimensions of 900 ft. width and 700 ft. length at the river bed; and 2,500 ft. of highway extension consisting of 26-ft. roadway with 18-ft. rolled screen gravel surface, adjoining the present compensating reservoir. Completion is scheduled for Dec. 1, 1936. The work is under the supervision of District Engineer Caleb Mills Saville.

Nine bids ranged from the contract low of $550,779 to a high of $759,525. The unit prices and totals of the three lowest bids follow. (A) B. Perini & Sons Inc. (contract), Framingham, Mass., $550,759; (B) Arute Bros. Inc., New Britain, Conn., $565,266; (C) John J. McHale & Sons Inc., Pawtucket, R. I., $571,155.

UNIT PRICES—BILLS BROOK DAM

	A	B	C
1. Clear and grub—10 acre	$86.00	$75.00	$150.00
2. Soil removal—12,000 cu.yd.	.28	35	.30
3. Excav. earth—110,000 cu.yd.	.18	.30	.25
4. Excav. rock, cove wall—3,000 cu.yd.	4.00	3.00	2.50
5. Excav. rock, blasting—3,000 cu.yd.	3.70	3.00	1.50
6. Rock surfacing, special—1,500 sq.yd.	.58	.40	.25
7. Rock fill—700 cu.yd.	1.00	1.00	1.00
8. Riprap—25,000 cu.yd.	1.53	1.00	1.75
9. Gen. fill, 12 in. layers—500,000 cu.yd.	.23	.29	.30
10. Gen. fill, 8-in. layers—140,000 cu.yd.	.23	.29	.30
11. Soil core & blanket—75,000 cu.yd.	.61	.40	.50
12. Spec. fill, 6-in. layers—45,000 cu.yd.	.28	.29	.30
13. Topsoil, dressed seeded—13,000 cu.yd.	1.00	1.00	.75
14. Tile drains to 8 in.—4,300 lin.ft.	.50	.50	.60
15. Tile drains, 10 to 15 in.—5,500 lin.ft.	.75	.75	1.00
16. Catch basins—48 each	75.00	75.00	60.00
17. Paving—850 cu.yd.	4.50	3.00	5.00
18. Concrete posts—142 each	3.00	3.00	3.50
19. Conc. masonry core wall—21,000 cu.yd.	4.35	4.50	4.00
20. Conc. masonry, gate house—1,100 cu.yd.	9.20	12.00	10.00
21. Granite face, gate house—3,000 sq.ft.	4.70	6.00	4.75
22. Granite curbing—1,150 lin.ft.	3.55	4.50	4.45
23. Drill holes—5,000 lin.ft.	.40	.50	.35
24. Grouting—100 cu.yd.	17.00	15.00	10.00
25. Portland cement—28,000 bbl.	2.75	2.25	2.30
26. Broken stone, gravel—8,500 cu.yd.	1.20	1.50	1.25
27. Woodbridge—total	1,500.00	700.00	1,400.00
28. Gravel surfacing—1,600 cu.yd.	2.00	2.50	3.00
29. Reinf. steel—230,000 lb.	.041	.035	.04
30. Misc. iron, steel—26,000 lb.	.12	.09	.10
31. Wire rope railing—2,700 lin.ft.	.45	.50	.50
32. Anchorages—12, each	10.00	10.00	10.00
33. Water-proofing 3 ply—3,300 sq.ft.	.25	.10	.20
34. Clean up—total	1,200.00	1,000.00	1,000.00

Muskingum Valley Levees

THREE levee construction contracts, forming part of the Muskingum water conservancy program, were awarded in July, 1935, by the U. S. engineers office, Zanesville, O. Capt. A. C. Lieber, Dist. Engr. The largest work located at Zoar, on the Tuscarawas River, 15 miles north of Dover, consists of 2 earth levees totalling 3,700 ft. in length, roadway ramps, drainage and discharge structures, and a 440-ft. diversion dam. Work is scheduled for completion 400 days after contract award. The levee protecting the transmission line tower is at Pavonia, on Black Fork, 6 miles northeast of Mansfield, O., is 990 ft. long, with berm at stream crossings, intake and outlet structures, and reinforced concrete footings for the tower structure, all of which work is scheduled for 120 days completion. The third project, located at Brewster, on a tributary of the Tuscarawas, about 10 miles southwest of Massilon, consists of 3 levees, totalling 2,005 ft. long, with cast-iron force main, diversion ditch, and drainage culverts, all scheduled for 120 days completion.

PWA minimum hourly wage rates prevail of $1.50 for skilled and 50 cts. for common labor. The following tabulation lists the unit bid prices of the three low bidders on each of the three contracts. Zoar levee: (A) O'Meara Const. Co., Inc., Quincy, Ill. (contract) $137,397; (B) York Eng. & Const. Co., York, Pa., $145,382; (C) Myers Bros., Campbellsburg, Ind., $151,765. Pavonia levee: (D) W. E. Thomson, Greenville Pa. (contract), $24,958; (E) R. E. Cary Co., Cleveland, O., $31,911; (F) Ed. C. Wurzer, Detroit, Mich., $41,416. Brewster levee: (G) Garaux Bros. Co., Canton, O. (contract), $23,586; (H) Ace Const. Co., Norwood, O., $24,675; (J) Harry H. Wise, Canton, O., $25,571.

LEVEE CONSTRUCTION, MUSKINGUM VALLEY PROJECT

	Zoar				Tower 52—Pavonia				Brewster			
	Quan.	A	B	C	Quan.	D	E	F	Quan.	G	H	J
1. Stream diversion—total		$2,000.00	$1,000.00	$200.00		$1,000.00	$1,500.00	$1,000.00				
2. Clear, grub, work sites—total		2,000.00	2,500.00	2,000.00		890.00	1,200.00	1,000.00		$500.00	$1,000.00	$500.00
3. Waste excavation—cu.yd.	2,750	.25	.50	.25	1,000	.25	.42	.40	10,000	.20	.30	.33
4. Excavation—cu.yd.	1,750	.50	1.00	.80	500	1.50	.90	1.50	450	.80	1.00	.75
5. Backfill—cu.yd.	1,240	.50	.50	.50	225	.75	.45	.50	300	.80	1.00	.50
6. Demolish concrete—cu.yd.	30	2.00	5.00	2.00								
7. Demolish rubble—cu.yd.	130	2.00	2.00	2.00								
8. Pervious fill—cu.yd.	280,000	.29	.30	.32	52,000	.31	.42	.60	35,000	.38	.37	.43
9. Impervious fill—cu.yd.	125,500	.27	.30	.32								
10. Seeding—acre	20	150.00	150.00	100.00	4	75.00	150.00	50.00	7	200.00	200.00	100.00
11. Riprap—cu.yd.	73	4.50	3.00	5.00	12	7.00	8.00	3.00	30	6.00	4.00	5.00
12. Rubble masonry—cu.yd.	48	5.00	10.00	12.00								
13. Concrete—cu.yd.	310	18.50	15.00	18.00	106	15.30	18.60	15.75	40	25.00	20.00	13.25
14. Reinforcing steel—lb.	71,500	.0425	.04	.05	5,000	.05	.04	.05	3,500	.05	.04	.05
15. Expansion joint assembly—lin.ft.	115	2.50	1.00	1.00	(a) 2	125.00	150.00	150.00				
16. Corrugated pipe, 36 in.—lin.ft.	80	4.00	8.00	11.00					309	8.50	9.00	9.85
17. Corrugated pipe, 60 in.—lin.ft.	140	8.00	12.00	17.00								
18. Vitrified pipe, 24 in.—lin.ft	367	2.75	2.00	2.00					(c) 590	1.55	1.60	1.65
19. Spiral welded pipe, 24 in.—lin.ft					424	5.84	6.00	8.00				
20. W. I. pipe vent assembly—lin.ft.	22	3.50	3.00	3.00								
21. W. I. pipe railing—lb.	460	.15	2.00	.10	570	.25	.20	.15				
22. Sluice gates, 36 in.—each	2	250.00	300.00	100.00	(b) 1	300.00	275.00	400.00				
23. Automatic drainage gates, 24 in.—each					1	25.00	25.00	40.00	(d) 3	125.00	130.00	52.33
24. Misc. iron, steel—lb.	566	.15	.20	.46	1,600	.05	.04	.05				
25. Metal seep rings—each									5	115.00	80.00	100.96

(a) Bull plug assembly. (b) 24-in. gate. (c) C. I. sanitary sewer, 6 in. (d) 36-in. gates.